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Agroecology for Europe (AE4EU)

Towards the development of agroecology in Europe

Deliverable report D2.2 – Inventory of Living Laboratories, Research Infrastructures and Agroecology Territories

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Executive summary

Living Laboratories (LL), Research infrastructures (RI) and agroecology territories (AT) are three types of initiatives that could help accelerate the agroecological transformation in Europe by fostering innovation and uptake of novel inventions/methods. In Part one of this deliverable, we investigate what defines an agroecological LL and how it differs from RIs. We investigate what topics, tools methods and actors are currently deployed in existing agroecological LL and RI respectively. To this end, we developed a trait database with 136 functional traits spanning the six main subfields (Innovation, Learning, Co-design, Implementation, Monitoring/Evaluation and Sustainability). The trait database was distributed to agroecological initiatives in the form of an online survey. Out of 99 contacted initiatives, 31 survey answers were derived, forming our trait database. We classed the initiatives as LL, RI or other in two ways, i) self-identification by reviewing the project name and description and ii) by a trait shortlist derived from the survey answers (Multiple actors in co-design, User involvement, Monitoring, Real-life setting, Transdisciplinary approach). Using ordination (NMDS, db-RDA) and cluster analysis, we determined what traits contributed to the similarity or dissimilarity between initiatives. We found that the number of actors involved, project continuation, funding use (restricted/unrestricted) were significant explanatory variables.

The optimal number of clusters in the initiative dataset were two. All initiatives that were self-identified as RI or RI/LL fusion were included in cluster one (RI cluster), while 69% of initiatives classed as LL were in cluster two (LL cluster). This indicates a systematic difference between initiative types. Notably, projects in the LL cluster were more likely to be self-dependent in their continuation, while initiatives in the RI cluster more often had a set end date (no continuation) and top-down governance. There were significantly more actors involved in the initiatives, as well as more actors directly involved in co-design, in the LL cluster. Scientists and farmers were the most frequent actors involved in both groups, while funders, industry and students were significantly more common as actors in the LL cluster compared to the RI cluster. Monitoring was not taking place in 23 % of initiatives in the LL cluster, and only 23% indicated that deficiencies in the project are evaluated. This may indicate that further efforts should be aimed at creating guidelines for monitoring progress and evaluating outcomes, as LLs are meant to be vehicles and examples for agricultural transformation. We also noticed a relative lack of digital competences in the LL cluster, which should also be improved. The trait shortlist did not succeed in singling out LLs from RIs. We also analyzed the trait distribution between initiatives with different funding streams and project continuation.

The development of Agroecology territories (AET) as a place-based upscaling strategy for agroecology was reviewed through literature search and expert interviews and presented in Deliverable D2.4. In this document, the findings are summarized, with the main conclusions being that AET should consider i) long-term strategies for multi-stakeholder cooperation, ii) bottom-up, community supported strategies, and iii) a transversal approach that connects food system strategies and sustainable management of common resources (biodiversity, water, land). Three schemes were identified as being relevant to support the AET concept: Bio-districts, Eco-model Regions and Regional Nature Parks (PNR) in France. It is concluded that AET and LL differ, but that AET and other territorial schemes could support the right conditions for LL establishment.

1. Inventory of Living Laboratories and Research Infrastructures

1.1. Introduction

Agroecology (AE) is a transformative approach to redesigning agri-food systems with the goal of achieving sustainability in environmental, socio-economic, and governance aspects. It involves transdisciplinary, participatory, and practice-focused research and initiatives that integrate scientific disciplines, agricultural practices, and social movements to drive food-system change (Wezel et al., 2020; FAO, 2018; Agroecology Europe, 2017; Gliessman, 2016). It aims to foster a sustainable approach to food production that is rooted in science-based ecologically sustainable farming practices, food sovereignty, local knowledge and identity, and social justice (Altieri & Toledo, 2011). AE as a concept has gained momentum within the framework of the European Green Deal, as an essential discipline for sustainable development of the food system and for restoration of biodiversity and soils (European Commission, 2021). However, many proposed agroecological interventions are not widely adopted by farmers and other food system actors, as they are not well adapted to the actor's specific needs. This deficiency could be amended by involving all food-system actors and stakeholders from the start of intervention design (Bohan et al., 2022). To this end, initiatives for inventing, testing and refining new AE-inspired methods through co-design must be effectively undertaken in many different environments and disciplines, together laying the groundwork for an urgently needed « agricultural transition «.

Living laboratories (LLs) have emerged as a valuable tool for conducting transdisciplinary and user-centered research, offering a unique approach to address complex challenges in various fields such as public health, urban planning and climate change adaptation (Steen & van Bueren, 2017). Essentially, these initiatives serve as real-world environments where researchers, practitioners, users and stakeholders collaborate to co-design and test innovative solutions within specific contexts, but a widely agreed-upon definition of LLs is still lacking (Campognucci et al., 2021). Originally described as a context in which researchers could prototype and test out solutions in real-life settings, the LL concept has evolved to go beyond traditional research settings by actively engaging stakeholders other than scientists throughout the research process. Local communities, policymakers, industry representatives, and other relevant actors participate in defining research questions, co-creating interventions, and implementing and evaluating solutions. By bringing together researchers from different disciplines, as well as farmers, industry actors and consumers, living laboratories could foster collaboration, knowledge exchange, and mutual learning when building towards an agroecological transformation of the food system (Bohan et al., 2022; ALL-Ready D1.1.

2021). Using the LL approach in agroecology is increasing in popularity, and its adaptation has been promoted by the European Commission (DG Agri note, 2021). Agroecosystems Living Laboratories (ALL) working group (MACS, 2019) define the concept of ALLs as:

"Transdisciplinary approaches which involve farmers, scientists and other interested partners in the co-design, monitoring and evaluation of new and existing agricultural practices and technologies on working landscapes to improve their effectiveness and early adoption."

Research infrastructures (RI) are defined by the *European Commission*[1] as:

"… facilities that provide resources and services for research communities to conduct research and foster innovation. They can be used beyond research e.g. for education or public services and they may be single-sited, distributed, or virtual."

The purpose of the RI is to conduct or to facilitate research. A RI can be an area designed for landscape experiments, a data collection, or a communication network. Since Living laboratories can contain, but must not contain, scientific research, the two concepts may not be mutually exclusive (e.g. an RI can include LLs in its services designed to facilitate research). One initiative can also include both the development of RIs and the conducting of LL-like activities. The two concepts are therefore hard to clearly define, and they can share multiple traits and partially overlap.

The concept of agroecological LLs is not well known outside of academia, although many initiatives use several of the core approaches of LLs without labeling themselves as such. The mapping of agroecology achieved within the AE4EU project has stressed this observation in different European countries (Wezel, Grard and Gkisakis, 2023). As a continuation of the mapping of initiatives conducted in Work package 1 of AE4EU, Work package 2 (WP2) Tasks 2.1-2.2 focuses on the analysis of ongoing and previous ALLs and RIs in Europe. The aim of WP2 is to identify tools and methods that support the development, monitoring and evaluation of LLs and RIs, ultimately contributing to best practice recommendations and tool boxes for the establishment of new agroecology initiatives. WP2 addresses six research questions:

1. What topics, skills, tools and methods are currently implemented in existing LLs and RIs?

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1 https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024/our-digital-future/european-research-infrastructures_en (Accessed 20-06-2023)

2. How do LL initiatives differ from other agroecological projects and RI?
3. Which characteristics of LL and RI appear to be particularly relevant for functioning and success?
4. What are the principles of successful transition towards agroecology and which guidelines can be provided for future LL and RI?
5. Which projects may serve as best practice examples for future LL and RI?
6. What are the key factors for sustainable transition at territorial scale using the concept of Agroecology Territories (AT)?

This Deliverable aims to answer Question 1-3. Question 4-5 will be addressed in the forthcoming Deliverable 2.3 and the results of question 6 is published in Deliverable 2.4 (not yet publicly available) and summarized in Part 2 of this document.

1.1.1. Conceptual approach

Conceptually, a living lab could be compared to an ecosystem with living organisms (different actors) and abiotic components (LL criteria) that are linked together (co-creation, co-development) to fulfill the specific function (outcomes: e.g. solutions or products). As such they are inherently complex, and very diverse. Since the definition of LLs are broad and the definition of AE itself encompasses a wide range of topics in the ecological, social, economic and cultural spheres, categorization of projects into distinct sub-clusters is difficult. A trait database with a trait concept borrowed from ecology (Violle et al., 2007) would enable the use of advanced statistical techniques such as ordination and cluster analysis to discern whether such categorization is possible, and what traits contribute to the distribution and variance of projects. Just as certain biomes can be identified through the presence of "indicator species", the presence of certain traits may be associated with the likely co-occurrence with other traits. This way, we can analyze how initiatives tend to combine the type of knowledge and actors they bring together with the implementation techniques (i.e. governance, funding, communication, evaluation) they utilize. Using this database, deficiencies in central aspects of project functioning such as knowledge sharing, monitoring and evaluation could be detected and quantified (Van Geenhuizen, 2018).

In Deliverable 2.1 (Mahdavi & Vandenbroucke, 2022), the development of the trait database, the survey designed based on the database, and the strategy for its distribution were outlined. Here, we present the results from the survey distribution and analysis. In this exploratory analysis, we aim to map the characteristics and functions of existing agroecology initiatives, to discern which traits or indicators are significant predictors of project likeness or differences. We aim to identify patterns in what human, social, agronomic and ecological dimensions agroecological initiatives operate in, as well as to determine how the initiatives differ in terms of organizational structure, outreach, knowledge sharing and actor involvement. We also want to highlight how and to what extent initiatives evaluate and monitor progress and deficiencies. We explore whether initiatives cluster together based on certain traits and if different "typologies" can be discerned using the trait-based approach. In an earlier study, Schuurman et al. (2013) defined four such typologies among LLs, one being projects that support in-context research and co-creation with users. We explicitly test if projects classed as LLs differ from projects lacking traits deemed essential to LLs. We then test what explanatory variables contribute the most to differentiating between projects. Finally, to demonstrate the trait databases' usefulness as an analysis tool and information bank, we test three "Use cases" in which we compare the trait frequencies between different clusters of initiatives, types of funding streams and project duration/continuation (Figure 1).

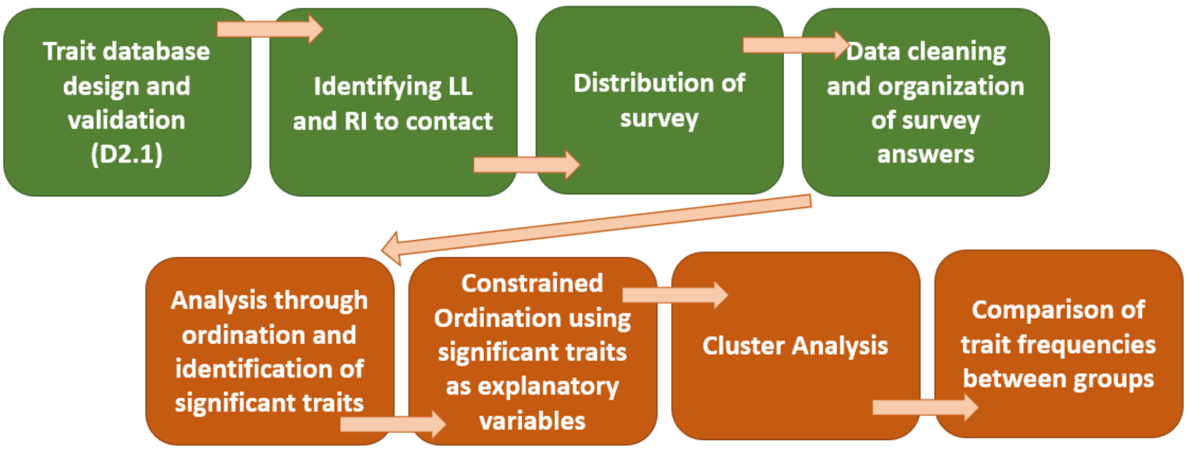

Figure 1. Schematic representation of the steps conducted and presented in the inventory of LL and RI.

1.2. Methods

1.2.1. Survey design

The agroecology initiative trait database was developed by the AE4EU team through multiple iterations of literature review (e.g. EU-reports, published articles, agricultural platforms), internal discussion, and consultations with experts (see Mahdavi & Vandenbroucke, 2022). This process resulted in a trait catalog consisting of six subthemes (Innovation, Learning, Co-design, Implementation, Monitoring/Evaluation and Sustainability), 25 indicators and 136 binary traits (Table 1, Figure 2, Appendix A). When designing the trait database, we considered the three main components of LL described in the MACS-G20 (2019) report on Agroecosystem Living Laboratories:

(i) transdisciplinary approach;
(ii) co-design and co-development with participants and

(iii) monitoring, evaluation, and/or research in real landscapes.

In the design and selection of indicators and traits specific to agroecological initiatives, the following sources were utilized:

- The ten elements of agroecology suggested by FAO (2018)
- The 13 principles of agroecology (HLPE, 2019)
- Indicators of sustainability assessment of food and agricultural system (SAFA indicators: FAO 2013)
- Indicators defined by CERAI (2019)
- List of agroecological practices (Wezel *et al.* 2014)

Traits and their indicators were designed as categorical data which are transformed in presence/absence form (1,0) in order to enable the statistical analysis of the data such as cluster analysis or multivariate analysis.

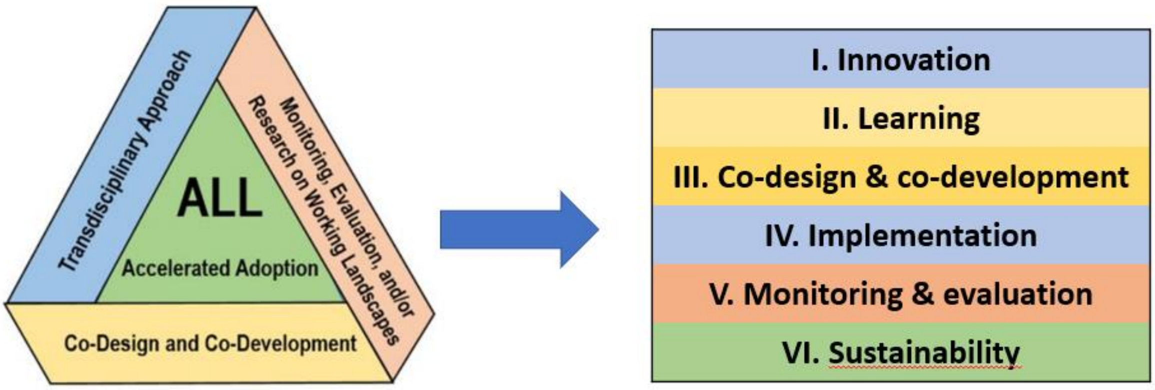

Figure 2. Schematic illustration of the principles of Agroecosystems Living Laboratories (ALL) from the working group (Agroecosystems Living Laboratories (ALL) Executive Report 2019, www.macs-g20.org) and how they were co-opted into the six subsections of the trait database (right).

After an attempt at assigning traits to initiatives based on the information gathered in the WP1 mapping database (Wezel, Grard & Gkisakis, 2023), BOND stories[2] and other EU project deliverables, the AE4EU team concluded that the best method for obtaining accurate information was to re-design the trait database into a survey questionnaire and approach the coordinators of initiatives directly. The trait database was thus re-formatted into a survey in

[2] https://www.bondproject.eu/repository-2/bond-projects/

an Excel sheet that could be distributed and filled in (See Appendix A for the full survey as presented to participants). The survey includes information on function and importance of each criteria and they are described in a simple and clear way with examples in order to avoid misunderstanding and misinterpretation of the indicators. The next phase of the project was thus to identify initiatives to contact, obtain digital contact information and distribute the survey.

Table 1. Overview of the traits and indicators that are used in the trait catalog. Six main categories are indicated (bold and underlined).

Indicators	Traits
<u>Innovation</u>	
Type of innovation	New technology/methods, new practices/processes, creative idea/concept, implementation/adaptation of existing solutions
Field of innovation	**Environmental elements**: Biodiversity, Soil, Water, Greenhouse gas regulation, Nutrient cycling, **Farming practices**: Crop choice, Plant & Animal breeding/Genetic breeding techniques, Crop-livestock integration, Fertilization/Nutrient mgmt., Weed, pest and disease management, Tillage management, Management of landscape elements, **Farming sector**: Arable crops/Permanent crops, Horticulture, Livestock, Grassland, Forestry, **Socio-economic practices:** Rural development, Food system, Food sovereignty, Marketing, Social movement and innovation, Education, Farmer co-operation, Agricultural diversification.
<u>Learning</u>	
Communication and learning tools	Internal meetings, Conferences & Seminars, Social media, Traditional media, Brochures/Vernacular documents/Newsletter, Field visits/Demonstration, Workshops & Trainings, Practices sharing groups & Group discussions
Digital competence	Website, Cloud/Chat portal, Network platform
Documentation	Scientific articles, Reports
<u>Co-design & co-development</u>	
Actors involvement	Number and type of actor (e.g. Scientists, Advisors, Farmers, Industry, Farmer organization/cooperative, Consumer (organization), Authorities/ Environmental organization, Funders, Retailers, Citizens/Volunteers, Policy makers, NGOs, students)
Objectives	Objectives are fixed initially and cannot evolve, Objectives are fixed initially but can evolve marginally, Objectives are fixed initially but can evolve significantly all along the project

Engagement of participants	At beginning and end of scientific activities, Throughout the research project but with fix research agenda/objectives, Throughout the research as well as in planning the research/objectives
User involvement	Using user data, For users, User participation, No user participation
Governance	Someone manages, facilitates and organizes the project, Different actors have an equal voice over the development of project, Governance integrates multiscale approaches from local to global, Informal governance
<u>Implementation</u>	
Real life setting	Field experimentation with farmers, Community supported innovation, Answer to local ecological issue
Transdisciplinary approach	Different scientific expertise is involved, actions/plans for maximizing the contribution of all participants
Funding type	Public, Private, Mix, No funding
Funding size	Small, Medium, Large
Funding duration	<3 years, 3-5 years, > 5 years
Use of fund	Restricted use, Unrestricted use
Continuity of project	(will be) Extended, Income from the activity allows savings and/or reinvestment in the activity itself, Project is/will be ended by end of the funding
<u>Monitoring & evaluation</u>	
Monitoring	Field monitoring, Monitoring the progress and result of project through scientific research, Long term monitoring of innovation cycles, Monitoring of impacts at food system scale, No monitoring
Evaluation	Actors agreed on problems/questions that need to be answered by project, Solutions to the specific problem are developed/Challenges are addressed, Effectiveness & efficiency of project is analyzed, Deficiencies are detected Environmental (ecological), economic, social & human, governance

Knowledge integration	
Sustainability	
Ecological	Natural resources, Biodiversity, Energy & Material, Animal welfare
Resource efficiency	Recycling, Input reduction
Economic	Investment, Economic diversification, Stability of supply/production & market, Product quality, Connectivity, Local economy (development), Waste & Risk-reduction
Social	social values and cultural diversity, Diet and nutrition awareness, Fair trade practice/Labor rights, Society and equity,
Political	Participation of producers in governance, Human safety and health, Education
	Corporate ethics, Responsibility & holistic audits, Rule of law, Resource mgmt. & full-coast accounting

1.2.2. Survey distribution

The survey was conducted online in two phases between June-August 2022 and February-April 2023. We actively contacted initiatives or their representatives via mail or their homepages. All initiatives labeled as LLs available in the WP1 mapping database at the time of survey distribution were contacted (N = 26). An additional 24 initiatives were selected from the database from other categories, including “Movement”, “Practices” and “Education”. An additional 45 initiatives were scouted from web searches or recommended by experts in the field of agroecology. These scouted initiatives did not explicitly have to mention agroecology in their description, but were all projects relating to one or several of the subject matters mention in the trait catalogue (Table 1). Since many initiatives use several of the core approaches of LLs without labeling themselves as such (Wezel, Grard & Gkisakis, 2023), the projects did not need to explicitly call themselves a LL or an RI.

Out of 99 contacted initiatives, 34 agreed to participate in the survey and 32 filled out the questionnaire and the accompanying consent form. One survey answer was excluded due to excess missing data. After the first round of surveys preliminary test analyses were conducted.

Based on their results, the trait database was expanded with four new traits (Actors: NGOs, Students; Field of Innovation: Farmer Co-operation, Agricultural diversification).

1.2.3. Data Analyses

1.2.3.1 Ordination

Ordination is a method in multivariate analysis that summarizes complex community data (such as species presence or absence from a sample) and produces low-dimensional ordination space in which similar samples (in this case initiatives) appear close together on an ordination plot with two or more axes. Similarly, species (in our case, traits) that often appear together, will appear close to each other on the resulting ordination plot. This method helps discern important explanatory variables for the variation among species communities (in our case, collections of traits in initiatives).

The survey answers were collated into a binary data matrix. Survey answers were corrected in order to avoid illogical trait combinations (e.g. surveys which had indicated the presence of both 'public' and 'private' funding was instead assigned to 'mixed' funding). Four instances of missing data were noted. All statistical analyses and graphical output were generated in R Statistical Software (v4.2.2; R Core Team, 2023). First, n*on-metric multidimensional scaling* (NMDS) was run on the full trait database in order to determine which trait vectors scored significantly (i.e. significantly contributed to the placement of sites in the ordination space) using the 'vegan' R package (Oksanen et al. 2022). The binary data matrix was transformed to a Simple Matching Coefficient (SMC) distance matrix, as presence or absence (1/0) holds equal amount of information in this particular matrix.

Based on the resulting ordination and trait scores from the NMDS, we extracted five indicators belonging to the 'Implementation' section of the survey. The funding size and funding length were transformed into semi-quantitative variables (0-4). Additionally, the number of actors involved in the project and the number of actors involved in co-design were added to the selection of explanatory variables. The indicators were transformed into a frequentist data table with three factorial and four (semi) quantitative variables (Table 2, Appendix A). This collection of explanatory variables was used to perform a constrained ordination using distance-based redundancy analysis (db-RDA) with R package 'vegan'. The best model (i.e. the model in which the selected variables explain the largest amount of variance in the ordination) was selected by forward selection of variables (Blanche et al. 2023) where explanatory variables are added stepwise using the "ordistep" function in R package 'vegan'.

Table 2. The explanatory variables used in the constrained ordination (db-RDA).

Factors	**Funding type**	*Public, Private, Mix, None*
	Funding use	*Restricted, Unrestricted*
	Project continuation	*Will be extended, Will not be extended, Self-dependent*
Vectors	**Funding size**	*1-4: None, Small (<€250,000), Medium (€250 - 500,000), Large (>€500,000)*
	Funding duration	*1-4: None, Short (<3 yrs), Mid (3-5 yrs), Long (>5 yrs)*
	N actors	*Number of actors involved*
	N design	*Number of actors involved in co-design*

1.2.3.2 Cluster analysis

We performed a hierarchical cluster analysis on the SMC distance matrix of the full trait database using the 'stats' base R package. The optimal number of clusters (n = 2) was selected based on a silhouette plot. Additionally, K-modes clustering was used on the same matrix to corroborate the results using the 'klaR' R package (Wheis et al., 2005).

1.2.3.3 LL and RI classification

We first classed initiatives as LLs or RIs based on their project description (if available), scanning their description for keywords (LL, user-centric, co-design, real-life setting), or referring to the classification performed in WP1. Since initiatives not classed as RIs were diverse, we ended up with six categories:

- LL
- LL and RI (i.e. RI used by LL or vice versa)
- Practice (after WP1 Mapping Vol.1)
- RI Education – Focus on educational material/databases for users
- RI Model Landscape – Physical area for experimentation
- RI Research – Specific research topic/tool

We then performed an internal categorization of the initiatives as LLs or non-LLs based on the presence of the following criteria (MACS-G20, 2019) which could be extracted from the survey answers:

- Multiple actors in co-design
- User involvement
- Monitoring takes place
- Real-life setting
- Transdisciplinary approach

We then compared whether the LL classification above matched the classification based on traits, and how the different classes matched the hierarchical clustering defined above.

1.2.3.4 Use cases

In order to test what information could be extracted from the trait catalog, we looked at a subset of indicators and how their prevalence varied for 1) the clusters defined in section 1.2.3.2 and 2) the different funding streams (Private, Public, Mixed) and 3) project continuation. We also compared the number of actors and the number of actors involved in co-design between clusters using a t-test, and between funding type and project continuation using an ANOVA.

1.3. Results

1.3.1. Survey distribution

Out of 26 contacted Living Laboratories from the mapping performed in WP1, 9 responded to our request for survey participation, and three projects responded belonging to the non-LL categories. Out of 49 initiatives sourced outside of WP1, 20 responded (Table 3). The geographical distribution of the included initiatives is seen in Table 4. The full trait database with the projects anonymized can be found in Appendix A.

Table 3. The source of contacted and responding initiatives in the Agroecology initiatives survey.

Source	N Contacted	N Responded
WP1 LLs	26	9
WP1 other	24	3
Non-mapped	49	20
TOTAL:	**99**	**32**

Table 4. Country from which responding initiatives originated. International projects were not restricted to a single country.

Country	N Responded
International	7
Austria	1

Cyprus	1
Finland	2
France	1
Germany	8
Greece	2
Italy	2
North Macedonia	1
Portugal	1
Slovenia	1
Spain	2
Switzerland	1
UK	1

1.3.2. Unconstrained ordination

Of the 136 binary traits, 97 scored significantly in contributing to the placement of the initiatives in the ordination space in the NMDS ordination ($p < 0.05$ N = 57; $p < 0.01$ N = 31; $p < 0.001$ N = 9; Figure 3). The first axis explained 13% of the variance among data points and the second axis explained 7%.

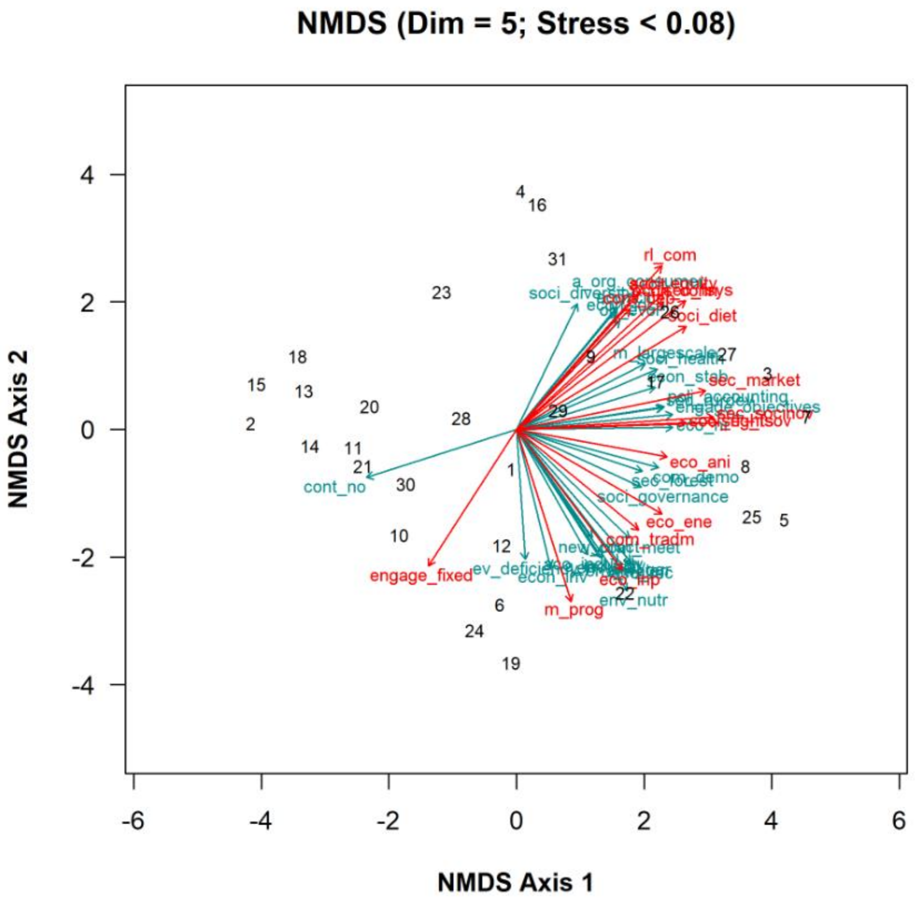

Figure 3. Ordination plot resulting from the NMDS ordination utilizing five dimensions and 999 iterations. The arrows represent significant trait vectors (Green = p < 0.01, Red = p <0.001). The numbers represent individual initiatives (1-31).

1.3.3. 1.3.3 Cluster analysis

The optimal number of clusters to best describe the distribution of the data points under hierarchical clustering were two (Figure 4A). Two clusters were defined in both hierarchical and k-modes clustering, with only one initiative being labeled differently between the two methods.

1.3.4. LL and RI classification

Seven initiatives lacked one or more of the LL internal criteria listed above (See 1.2.3.3), based on their survey answers. Two of the initiatives self-identifying as LLs in their project descriptions lacked LL traits according to the survey, while five of the initiatives not classed as LLs according to their descriptions fulfilled all the LL criteria according to the survey (Figure 4B). All but one initiative indicated transdisciplinary approach and multiple actors involved in co-design. No initiative indicated no user involvement, but four initiatives did not specify the type of involvement. Four projects indicated no monitoring, and three projects indicated no real-life setting.

Of the 31 initiatives, 16 were classed as LLs based on their own description (Figure 4D). Four initiatives ('RI and LL') had aspects of both RI and LL, or were RIs that were put to use by an LL. Two initiatives were RIs related to education material and three were RIs providing model landscapes. Four projects had distinct research profiles, and may not fit under either LL or RI ('RI Research'). In the unconstrained NMDS ordination, the non-LL initiatives did not form a distinct cluster (Figure 4B), while the different RI initiatives clustered together (Figure 4D). Funding type did not form a distinct pattern in the ordination space (Figure 4C).

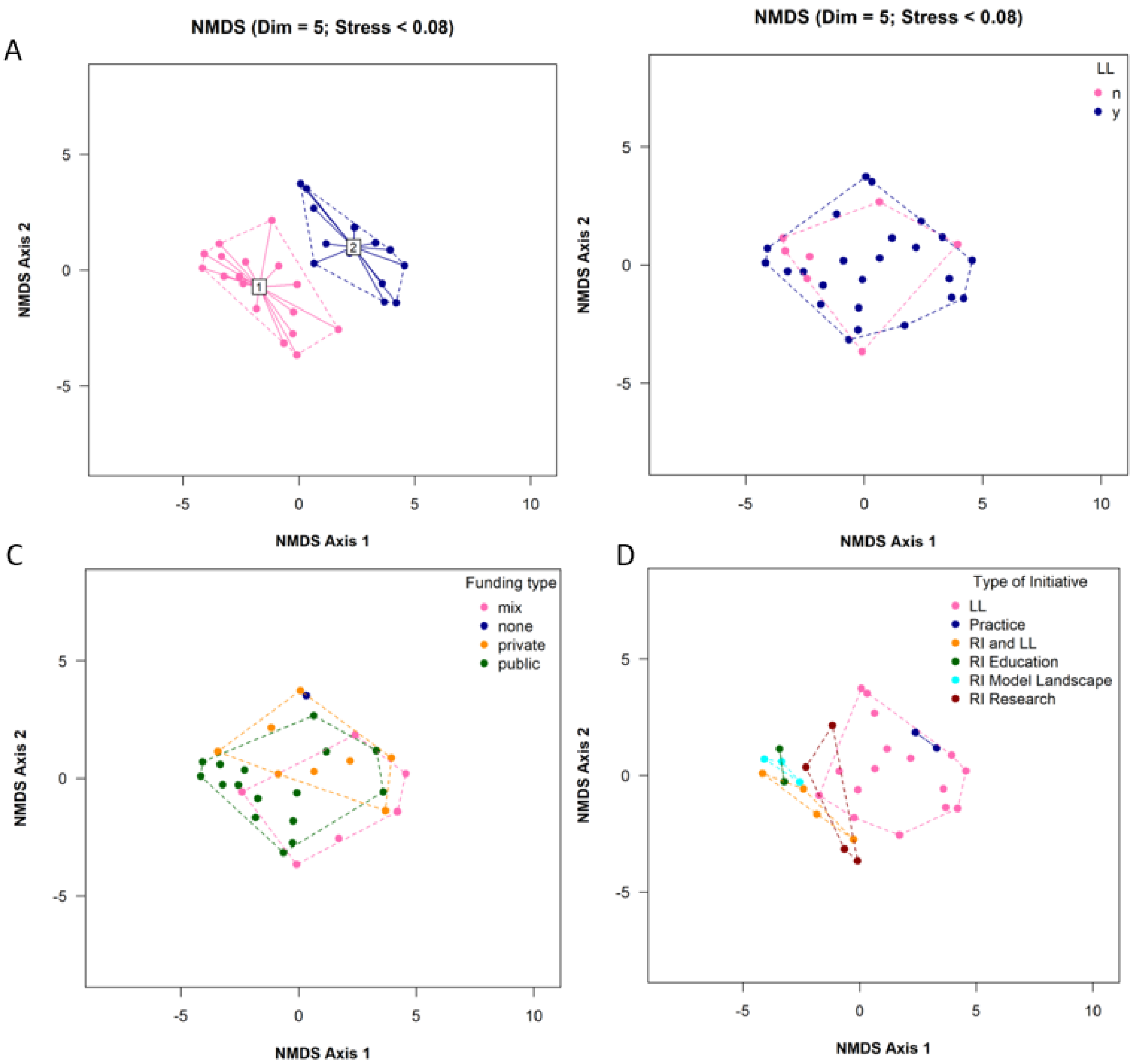

Figure 4. Ordination plot resulting from the NMDS ordination showing the two clusters resulting from the hierarchical cluster analysis (A), the internal categorization **into LLs and non-LLs (B), and initiative funding type (C) and type of initiative based on project description/self-identification (D).**

1.3.5. Constrained ordination

In the db-RDA, the constraining variables explained 43% of the overall variance. When adding variables stepwise, including only the number of actors and project continuation was the best fitting model. When only these variables were included in the constrained ordination, they explained 18% of the variance. Since this model was not significantly better fit for the data (ANOVA, p >0.05), we performed the constrained ordination on the full model (Table 5). The variables Number of actors, Project continuation (Will continue, Will not continue, Self-dependent), Number of actors in co-design and Funding use (Restricted, Unrestricted) were all contributing significantly to the ordination (Figure 5A). The variables Funding type, duration and size did not.

Table 5. Distance-based Redundancy Analysis (db-RDA) on the full model of explanatory variables. Given are degrees of freedom (Df), F-value and p-values.

Variable	*Df*	*F*-value	*p*-value
N actors	1	2.4578	0.005**
Project continuation	2	2.0070	0.005**
N design	1	2.1040	0.010**
Funding use	2	1.3548	0.040*
Funding type	3	1.2531	0.085
Funding duration	1	0.9183	0.565
Funding size	1	0.8443	0.675

Initiatives whose continuation is self-dependent formed a distinct group in the ordination space (Figure 5B) and were separated from initiatives with a pre-determined end date but not from those with a determined continuation path (Will continue).

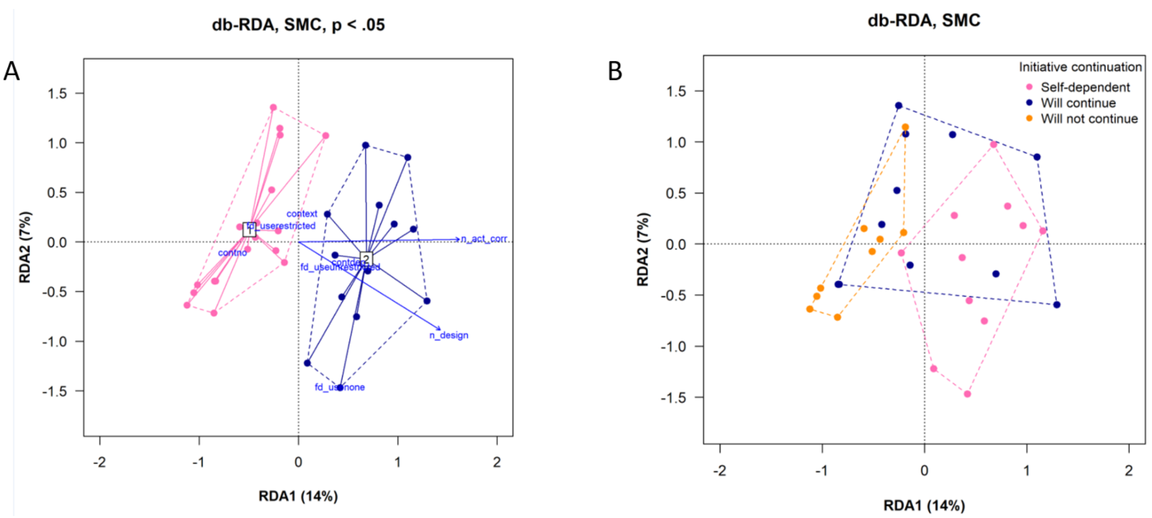

Figure 5. Distance-based Redundancy Analysis (db-RDA) ordination plot with significant (p < 0.05) explanatory variables overlayed in blue showing (A) the two clusters resulting from the hierarchical cluster analysis and (B) the clustering based on continuation of initiatives.

1.3.6. Trait database use case 1: Traits among clusters

Here, we discuss a subset of the traits that defined the two clusters in section 1.3.3 (Figure 5A). What defines the two clusters? All initiatives classed as RIs were included in cluster 1, while 69% of initiatives in cluster 2 were LLs (Figure 4D). As evident from the similar ordination of the clusters and the project continuation levels (Figure 5A-B), projects in cluster 2 are more likely to be self-dependent in their continuation.

There were more actors involved per initiative in cluster 2 ($t = -2.4$, $df = 28.7$, $p = 0.03$; Figure 6A) as well as more actors involved in co-design ($t = -2.5$, $df = 17.2$, $p = 0.03$; Figure 6B). Cluster 2 initiatives have a higher representation of farmer organizations, retailers, industry actors, students and non-governmental organizations, while cluster 1 initiatives are more likely to contain environmental authorities (Table 6). In both clusters, scientists were the most common actor followed by farmers. Funders were represented as actors in 46% of initiatives in cluster 2 and only 6% of initiatives in cluster 1.

The clusters also differ based on what field of innovation the initiatives are active in. Cluster 1 initiatives more often deal with management of landscape elements, crop choice practices, and farmer education. Cluster 2 projects mention agricultural diversification, farmer co-operation, plant/animal breeding, and permanent/arable crops as field of innovation (Table 6). Both clusters are equally invested in biodiversity-enhancing measures (83% and 77% respectively) and soil management (72% vs 77%).

Taken from the "Implementation" section of the trait database, we look at the "Monitoring" and "Governance" indicators. We see that top-down governance and multiscale governance are more common in cluster 1, while initiatives in cluster 2 are more likely to have an informal governance structure (14% vs. 43%). In cluster 1, all initiatives engage in monitoring through scientific research, while only 29% of initiatives in cluster 2 do. Only 14% of initiatives in either cluster monitor at a food system scale and 14% of initiatives in cluster 2 do not monitor progress, which disqualifies them as an LL according to the criteria established in this study. When looking at the indicator "Evaluation" (not shown in Table 6) none of the trait ratios differed between the two clusters, although engagement was singled out as a highly significant trait in the unconstrained ordination. In the "Communication" section (not shown), most of the initiatives in cluster 2 (92%) use field visits/ demonstration as a means of communication and knowledge sharing, while only 67% of projects in cluster 1 do the same. Among "Digital competences", Projects in cluster 1 are more likely to have websites (83% vs. 62%) and digital platforms (39% vs. 15%) compared to cluster 2 initiatives (not shown in Table 6).

Table 6. The ratio of traits of selected indicators between the two clusters defined in the hierarchical clustering. The overall prevalence of the traits are indicated in the second column. Green color in the first column indicates that the trait was significant in the NMDS ordination. The blue and red color illustrate the relative value in the field as a visual aid (Blue = higher, Red = lower).

Trait	**Overall (n=31)**	**Cluster 1 (n=18)**	**Cluster 2 (n=13)**
Actors involved			
Scientists	90%	94%	85%
Farmers	90%	94%	85%
Advisors	65%	61%	69%
Farmer organisation/cooperative	65%	56%	77%
Authorities/ Environmental organisation	65%	72%	54%
Citizens/Volunteers	48%	56%	38%
Industry	39%	22%	62%
Policy makers	39%	39%	38%
Students	39%	17%	69%
NGO	35%	22%	54%
Consumer organisations	29%	28%	31%
Retailers	29%	17%	46%

Funders	23%	6%	46%
Governance			
Someone manages the initiative	52%	67%	31%
Governance integrates multiscale approaches	29%	11%	54%
Informal governance	23%	22%	23%
Actors have an equal voice / Flat governance	13%	22%	0%
Monitoring			
Field monitoring	71%	72%	69%
Monitoring through scientific research	61%	67%	54%
Long term monitoring	26%	22%	31%
Monitoring of impacts at food system scale	19%	22%	15%
No monitoring	13%	6%	23%
Field of Innovation			
Biodiversity	81%	83%	77%
Soil	74%	72%	77%
Management of landscape elements	74%	89%	54%
Arable crops/permanent crops	74%	67%	85%
Rural development	65%	67%	62%
Education	58%	67%	46%
Water	55%	56%	54%
Crop choice	52%	72%	23%
Horticulture	52%	50%	54%
social movement and innovation	48%	50%	46%
Weed, pest and disease management	45%	50%	38%
Food system	45%	44%	46%
Nutrient cycle	42%	39%	46%
Co-operation among farmers	42%	22%	69%
Grassland	42%	44%	38%
Fertilisation/Nutrient management	39%	39%	38%
Food sovereignty	39%	39%	38%
Marketing	39%	44%	31%
Greenhouse gas regulation	35%	44%	23%
Tillage management	35%	44%	23%
Livestock	35%	33%	38%

Plant & animal breeding/Genetic breeding techniques	26%	11%	46%
Agricultural diversification	26%	11%	46%
Crop-livestock integration	23%	22%	23%
Forestry	10%	11%	8%

1.3.7. Trait database use case 2: Trait variability among Funding streams

The type of funding a project received contributed to its placement in the ordination space, as funding type was not included in the list of significant explanatory variables (Table 5) and their distribution in the NMDS ordination did not result in clusters (Figure 4C). However, when looking at a selected subset of indicators, it is apparent that the different funding streams lead to variable trait distributions, thus this example is added as an illustrative use case.

The type of innovation most common in privately funded initiatives (n = 7) were creative ideas and new technologies, while only 35% of publicly funded projects invented new technologies/methods (Table 7). There was no difference in the number of actors involved between the different categories (Figure 6C).

Community-supported innovation was a more common real-life setting in privately funded initiatives compared to publicly funded (86% vs. 35%). Field monitoring was overall the most commonly selected form of monitoring. All of the mixed-funding projects monitored through scientific research, while only 29% of private and 65% of publicly funded projects did. Only 12% of publicly funded initiatives indicated long-term monitoring, compared with 50 % of mixed and private initiatives. 13% of all initiatives indicated no monitoring.

When considering knowledge integration, initiatives with mixed funding often generated governance knowledge (83%) or social knowledge (83%), while publicly funded projects were more often preoccupied with environmental knowledge (Table 7).

Table 7. The ratio of traits of selected indicators between the three funding streams (Mixed, Private, Public). One initiative was labeled as "No funding" and was therefore excluded. The overall prevalence of the traits are indicated in the second column. Green color indicates that the trait was significant in the NMDS ordination. The blue and red color illustrate the relative value in the field as a visual aid (Blue = higher, Red = lower).

Trait	**Overall (n=30)**	**Mixed (n=6)**	**Private (n=7)**	**Public (n=17)**
Type of innovation				
Implementation/Adaptation of existing solutions	81%	100%	71%	82%

Creative idea/concept	74%	83%	86%	65%
New practices/processes	71%	67%	71%	71%
New technology/method	48%	50%	86%	35%
Real-life setting				
Field experimentation with farmers	65%	67%	71%	65%
Answer to local ecological issue	48%	50%	43%	47%
Community supported innovation	45%	50%	71%	29%
Monitoring				
Field monitoring	71%	83%	71%	65%
Monitoring through scientific research	61%	100%	29%	65%
Long term monitoring	26%	50%	43%	12%
Monitoring of impacts at food system scale	19%	17%	14%	18%
No monitoring	13%	0%	14%	18%
Evaluation				
Solutions to specific problem are developed	81%	100%	71%	82%
Actors agreed on problems/questions to be answered	68%	67%	57%	76%
Effectiveness & efficiency of project is analysed	45%	67%	43%	41%
Deficiencies are detected	35%	67%	14%	35%
Knowledge integration				
Environmental (ecological)	84%	100%	71%	82%
Economic	71%	67%	71%	71%
Governance	65%	83%	57%	65%
Social & human	61%	83%	71%	47%

1.3.8. Trait database use case 3: Trait variability among Initiative continuation

Initiative continuation influenced the ordination (Figure 5B). Initiatives that were not extended (i.e. had a pre-determined end date) were predominantly publicly funded (89%), while projects whose continuation was self-dependent projects were most often privately funded (55%). User engagement was the most intense in self-dependent initiatives, where all initiatives engage in research and in planning the objectives, while that was only true for 22% of fixed-duration projects (Table 8).

Forty-five percent of self-dependent initiatives monitor impacts on food-system scale (45%), or monitor long term (36%), while none of the fixed-duration initiatives did. Objectives could significantly evolve in all of the self-dependent projects, and in 56% of the fixed-duration project (Table 8). There was no difference in the number of actors involved between the different categories (Figure 6D).

Table 8. The ratio of traits of selected indicators between the three project continuation alternatives (Self-dependent, Extended, Not extended). One initiative was labeled as "No funding" and was therefore excluded. The overall prevalence of the traits is indicated in the second column. Green color indicates that the trait was significant in the NMDS ordination. The blue and red color illustrate the relative value in the field as a visual aid (Blue = higher, Red = lower).

Trait	Overall (n=31)	Self-dependent (n = 11)	Extended (n = 11)	Not extended (n = 9)
Funding type				
Public	52%	27%	55%	89%
Private	23%	55%	0%	11%
Mixed	19%	9%	45%	0%
None	3%	9%	0%	0%
User engagement				
Throughout the research as well as in planning the research/objectives	65%	100%	64%	22%
Throughout the research project but with fix research agenda/objectives	39%	0%	55%	67%
At the beginning and end of scientific activities	10%	0%	18%	11%
Monitoring				
Field monitoring	71%	64%	73%	78%
Monitoring the progress and result of project through scientific research	61%	45%	91%	44%
Long term monitoring	26%	36%	36%	0%
Monitoring of impacts at food system scale	19%	45%	9%	0%
No monitoring	13%	9%	0%	33%
Objectives				
Objectives are fixed initially but can evolve significantly all along the project	77%	100%	73%	56%
Objectives are fixed initially but can evolve marginally	23%	9%	27%	33%
Objectives are fixed initially and cannot evolve	6%	0%	9%	11%

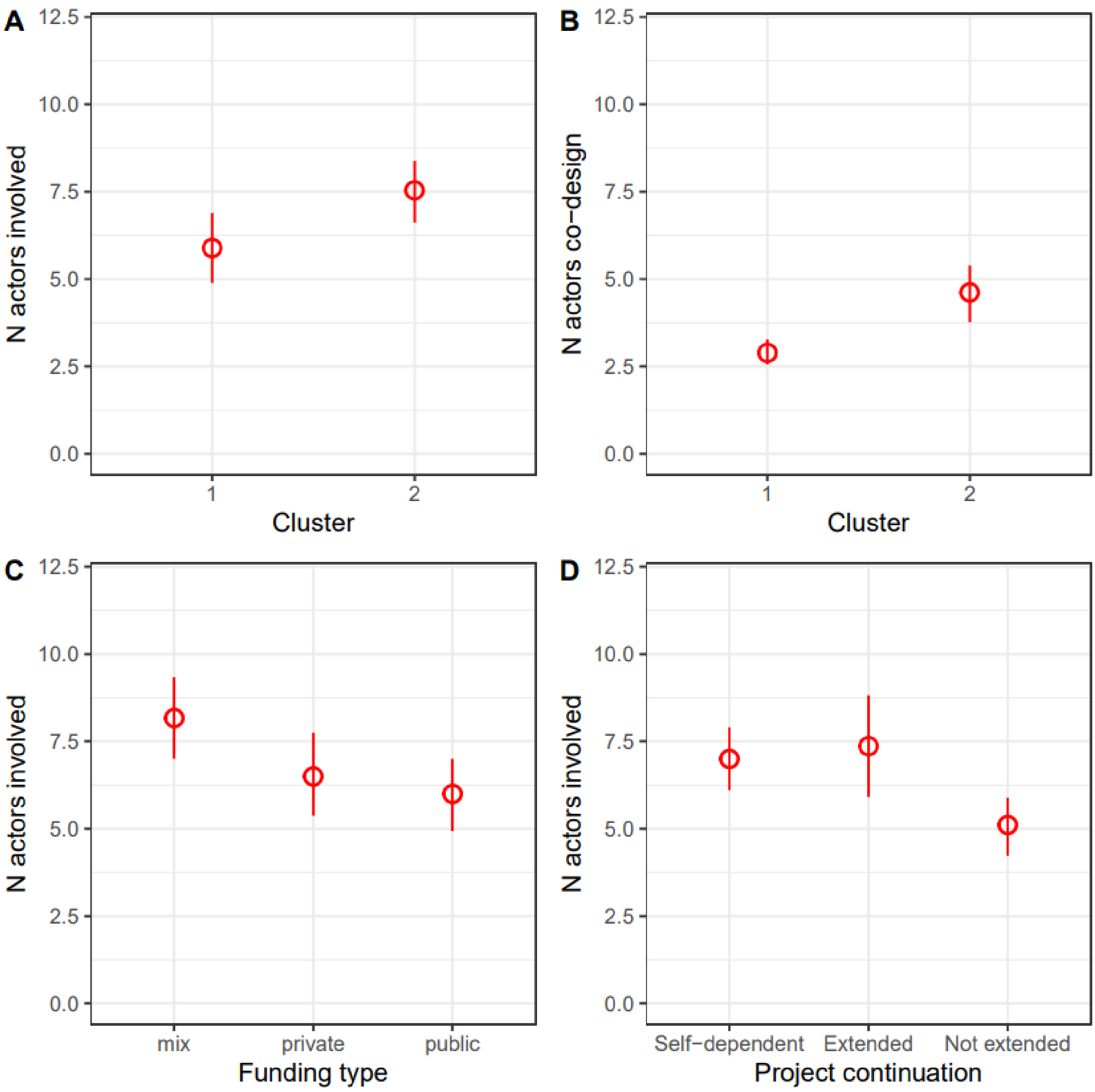

Figure 6. Mean and 95% confidence interval (dot and whiskers) of the number of actors involved in the initiatives per cluster (A; T-test p < 0.05), actors involved in co-design per cluster (B; T-test p < 0.05), actors involved by funding stream (C; ANOVA, n.s) and actors involved by project continuation (D; ANOVA, n.s).

1.4. Discussion

The ordinations we performed indicate a large variety of initiatives with different trait combinations. The low percentages of explained variance in the ordination axes indicate that there are many indicators that contribute to the diversity of initiatives and that it is difficult to derive initiative "typologies".

Does the trait database help with classifying different types of initiatives? All initiatives classed as RIs were included in cluster 1, while 69% of initiatives in cluster 2 were LLs, indicating a quantifiable difference in trait occurrences that could be captured by the trait database. In terms of "typologies", we see a cluster of RIs and LL initiatives that resemble them (i.e. in cluster 1). These initiatives were more likely to be top-down governed, publicly funded and have a set end-date. The different sub-classes of RIs cluster together in our ordination, despite the very diverse end products they represent (e.g. educational material, experimental plots, or seed databases). When comparing to the typologies defined in Schuurman et al. (2013), the initiatives in our cluster 2 seem to fall within his two first clusters defined there, i.e. 1) small-scale & real-world user co-creation and 2) long term knowledge sharing & collaboration.

The comparatively small number of LL active in long term or food-system-level monitoring (and the subset not monitoring at all) raises concern about the idea that LL should be purpose-driven in the sense of accelerating a transformation of European agriculture towards the application of sustainable practices. Without an active monitoring of success, it may remain unclear whether and how such transformations were achieved in the respective LL.

The concept of agroecology LLs and RIs will be growing in importance, and the development of new funding schemes is already underway. A common definition of what constitutes an agroecology LL and RI and what does not would greatly benefit the design and implementation of such funding schemes, as the loose definitions can be a hinderance in what is required for a successful implementation of an LL that actually leads to accelerated adaptation and useful inventions (Bohan et al., 2022). In order to truly make ALLs a useful tool in accelerating the agroecology transition, better tools for monitoring and evaluation are needed (Van Geenhuizen, 2018). Standards for defining objectives, engaging users, evaluating and monitoring of results must be clearly defined, and with that a clearer distinction between LL as a methodology and other research initiatives or infrastructures can be achieved.

2. Inventory of Agroecology Territories

The main goal of T2.3 was to analyze the current development of Agroecology territories (AET) or equivalent concepts in Europe and question the relevance of this concept as an upscaling pathway for agroecology, considering economic, environmental and social aspects. A literature review as well as semi-structured interviews with country informants and key informants regarding potential AET were achieved, and results were published in Deliverable 2.4 "Agroecology Territories as targets of agroecological transformation in Europe».

The main conclusions of this work highlighted the following points. The literature review shows that a place-based or territorial approach for agriculture and food transition is relevant and that such a territorial approach should consider:

- Long-term strategies for multi-stakeholders' cooperation and learning processes. The development of territorial synergies for agroecology is not a short-term issue. It relies on long-term coordination among stakeholders and on learning processes that provide capacities for adaptation to external factors (Piraux et al., 2018; Vandenbroucke et al., 2020; Mehmood et al., 2020).
- Bottom-up and community supported strategies. Place-based approaches for transition can integrate community issues and livelihoods and the importance of bottom-up approaches emerge as a result of different analyses (Dias et al., 2021). They contribute to empower communities in grounding and re-position their strategies within the frame of dominant regimes (Horlings et al., 2020).

A transversal approach that connects food system strategies and sustainable management of common resources (biodiversity, water, land) (Gascuel & Magda, 2015; Wezel et al., 2016; Lamine et al., 2019).The analysis achieved highlights the gradual emergence of different territorial schemes over Europe that support transitions to sustainable food systems, with three main roots in rural development, territorial food systems, and agri-environment and biodiversity conservation. Pathways of those schemes reveal that their scope enlarges progressively to integrate new issues and topics. The current use of the concept of AET in the literature seems to be limited to a specific community whereas an important body of literature was found on comparable territorial schemes or promoting the relevance of territorial approaches.

Three schemes have been identified as having a good potential toward AET: Bio-districts, Eco-model Regions and Regional Nature Parks (PNR) in France. The comparison of those schemes through case studies provides interesting insights regarding the conditions, levers and barriers for sustainable transition pathways at territorial level.

The AET concept appears throughout this work as a fertile and promising frame to design and extend current existing territorial schemes and their area of action to promote the development of agroecology. Further work on the potential to implement the concept through existing territorial schemes seems to be necessary as well as a further analysis of the numerous existing territorial schemes and their area of action in relation with the concept of AET. Recommendations and perspectives towards the development of agroecology territories are drawn.

Within the overall frame of the AE4EU project, we question whether AETs could be considered as specific type of LLs. The TETRAA programme[3] , could be a good example of an AET LL as it aims to encourage territorial innovations, including users, research infrastructure and covering the three dimensions of adaptation of agricultural practices, conservation of biodiversity and natural resources and embeddedness of local food systems through a systemic approach at territorial scale.

Nevertheless, our results highlight that AET and LL are different concepts that might have different temporalities (innovation-based project versus long-term territorial strategy – but both can apply to either AET or LL as not yet clearly defined), objectives (problem-based innovation versus long term place-based transformation), stakeholders (territorial multi-stakeholder versus more problem-solving oriented selection of stakeholders). AET could rather be considered in their capacity to encapsulate and foster conditions for the development of LLs. In fact, it could be demonstrated that AET can enhance conditions to support the development of LLs, and even improve the transformative capacity of them. In the Pilat PNR case study, the role of the PNR to enhance the creation of a group of farmers engaged in change of practices (Groupement d'intérêt économique et environmental – group of economic and environmental interest; GIEE) highlights that the key contribution of the PNR to support the administrative application of the group of farmers, enlarge the panel of local stakeholders involved in the project and thus amplify the scope of action including education in technical high school and sensitized future young farmers.

[3] https://programme-tetraa.fr/le-programme/

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Appendix A.

The Survey, the database of survey answers, and the Trait subset used as explanatory variables are attached in an Excel file.