Agroecology for Europe (AE4EU)

Towards the development of agroecology in Europe

Deliverable report D1.3 – Report on agroecological research development

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Executive summary

Through the mapping of projects, programmes and institutions (PPIs) involved in agroecological research in Europe at different levels (National, Transnational and European), this deliverable aims i) to assess how agroecology (AE) is understood and perceived by research planners and designers; ii) to characterize research on agroecology in terms of implementation of agroecological elements; and iii) to evaluate the role of current AE research, assessing if it is conform to the dominant regime or if it promotes transformation of current agri-food systems.

The deliverable is organized in **four sections**: **1. Introduction** where the reasons that led to this study are explained; **2. Methodology** with the description of the four-step methodology carried out in the study. They are: a. *Creation of a database on PPIs* (3/2021 – 10/2021) to collect principal data and information related to PPIs; b. *Launch of three surveys* (4/2021–3/2021) (for the coordinators of the identified projects, the leaders of programmes, and researchers involved in agroecology) using information collected in the previous step; c. *Data analysis and evaluation* (2/2022 – 5/2022) to understand connections among European countries through, a Social Network Analysis (SNA), and identify how agroecology is used by scientific community and implemented in funding programmes at European, Transnational, and National level. d. *Reporting* (5/2022 – 6/2022). This section also describes the structure and information contained in the final version of the database on PPIs released together with this deliverable; **3. Results** where the main results obtained from the SNA and the three surveys are reported and discussed; **4. Conclusion and recommendations** where lessons learned and recommendations for future research agendas to better strengthen AE and its transformative role in Europe are provided. A summary of these recommendations is given in **box 1** at the end of the deliverable.

1. Introduction

Agroecology (AE) is a way of redesigning agri-food systems, with the aim to achieve environmental, socio-economic, and governance sustainability. Through transdisciplinary, participatory, and change-oriented research and actions, AE is based on an integration of scientific disciplines, agricultural practices, and social movements focused on social change (Gliessman, 2016; Wezel et al. 2009). Its definitions, scales, and dimensions changed and enriched over the time. At present, agroecology goes beyond the farm and the agroecosystem (Gliessman, 2015) embracing the whole food system described by Wezel at al. (2016) as "*a socio-technical network linking people, natural elements, and artifacts that interact with food issues*". AE aims to achieve transformations in the food system promoting a holistic and sustainable approach to food production relaying on place-based food interactions, food sovereignty, local knowledge and identity, and social justice (Altieri and Toledo, 2011; Nyéléni, 2015; Rosset et al., 2011). Therefore, from its origins, as a branch of agricultural science, agroecology has developed into a transdisciplinary field in which political and social questions are currently addressed, as well. It represents a collective-action mode for challenging and contrasting the dominant agri-food regime and creating more sustainable alternatives (Levidow et al., 2014), moving away from the globally standardized and business-oriented approach of the current agriculture, toward a process of redesigning food systems to achieve ecological, economic, and social sustainability (Gliessman, 2016).

In contrast to this transformative agenda, AE has also been adopted by actors who promote the conventional agriculture and the agro-industrial productivist model (Holt-Gimenez and Altieri 2013). They support conservation agriculture and sustainable intensification as agroecological methods for increasing productivity within the dominant agri-food regime legitimising a biotechnological paradigm, addressing environmental harms associated with industrial agriculture (Alonso-Fradeyas et al., 2020).

According to these two visions (transform *vs* conform), agroecology can play a very different role. Amongst the broad range of topics identified in European agroecological research (Wezel et al., 2018), some research approaches are more in line with the dominant agri-food regime, while others are able to better integrate the participation of different actors and promote a territorial development with a wider transformative role. The two different roles of agroecology and the related applied research strategies can lead to very different outcomes in terms of emerging socio-technical system. Analytical distinctions are therefore necessary to identify research elements in agroecology characterized by a transformative potential. This

will allow to set up appropriate research agendas within the funding research programmes at European[1], Transnational[2], and National[3] levels supporting this transformative direction.

With this in mind, the main aim of this deliverable is to map projects, programmes and institutions (PPIs) involved in agroecological research in Europe at different levels (National, Transnational and European) to:

i) assess how AE is understood and perceived by research planners and designers;
ii) characterize research in terms of implementation of AE elements;
iii) evaluate if the current AE research really contributes to create alternatives and transform the current agri-food regime.

2. Methodology

A **four-step methodology** was opportunely designed and carried out to achieve the above-described aims. Namely:

1. **Creation of a database on PPIs** (3/2021 – 10/2021) to collect principal data and information related to PPIs involved in AE research in the last years (starting from 2014 according to the Horizon framework). The final version of the database on PPIs (file: AE4EU_db_PPIs.xlsx) is released together with this deliverable;
2. **Online surveys** (4/2021–3/2021). Using information collected in the previous step, three different online surveys (for the coordinators of the identified projects, the leaders of programmes, and researchers from academic or other private and public research institutions in Europe involved in agroecology) were conducted to better understand the role of agroecology in European research;
3. **Data analysis and evaluation** (2/2022 – 5/2022). All data collected through the different surveys were analysed to understand how AE is used by scientific community at European, Transnational, and National level. Moreover, a social network analysis (SNA) was carried out using the package *igraph* (Csardi and Nepusz, 2006) of R

[1] *European programmes*: funding programmes for research framed and funded by European Union (i.e., work programmes of Horizon framework);

[2] *Transnational programmes*: funding programmes for research co-framed and co-funded by transnational initiatives and member States (i.e., ERA-NETs in the past Horizon framework and European Partnerships of Horizon Europe);

[3] *National programmes*: funding programme for research totally framed and funded by each Member State

software to understand connections among European countries and identify the most powerful and influential countries in the research in AE;

4. **Reporting** (5/2022 – 6/2022)**.** The results of the analysis were reported in this deliverable and some recommendations were draft for future research agendas able to better support AE and its transformative role.

2.1 Database on PPIs

Information to fill in the database was obtained **carrying out desktop research** especially for the European and the Transnational levels by consulting the main relevant available databases on funded projects. For national projects and programmes for which it was difficult to find information in English, we used **information coming from task 1.1** and we contacted **by email relevant stakeholders** (e.g., national funding agencies).

2.1.1. European research projects and programmes

The list of European research projects related to AE funded by the European Union under the Horizon 2020 framework programme from 2014 onwards reported in the database was obtained consulting: the **CORDIS** database and **EURAKNOS** thematic networks.

With the aim to include in our list the EU projects where the term "agroecology" was explicitly mentioned, we used the following truncated keywords to perform our preliminary research in the CORDIS database: **agroecolog*** (to include both agroecology and agroecological) and **agro-ecolog*** (for agro-ecology and agro-ecological).

However, in order to include more projects that did not explicitly mention agroecology but that could be referred to agroecological sound approaches and to be consistent with the methodology proposed by WP3, we considered the additional following keywords: **agroforestry, silvopasture, silvoarable**, **food justice, food system, territorial food system, food sovereignty and rural development.**

Using this methodology, we obtained the following results from the CORDIS database:

agroecolog* -> 43 projects
agro-ecolog* -> 1880 projects (further narrowed to 261 results by considering only the *Domains: Food and Natural resources, and Society*)
agroforestry -> 16 projects
silvopasture -> 2 projects
silvoarable -> 1 projects

food justice -> 0 projects
food system -> 101 projects
food sovereignty -> 3 projects
rural development-> 22 projects

Regarding the EURAKNOS thematic networks, since it is made up of only 35 projects, no keywords have been searched but all the projects were viewed.

All identified projects were analysed by a team of researchers from CREA and FIRAB using information available on the websites. Only projects where agroecology was explicitly mentioned, or the projects that were characterized by a strong actor engagement and addressed the criteria at least of the level 3 (system redesign) of the framework proposed by Gliessman for classifying food system change (Gliessman, 2015) were included in the database. For this purpose we considered the list of topics and criteria reported in the **Agroecology Criteria Tool (ACT)** methodology which are based on the work carried out by DeLonge et al. (2016). In case of doubts, the projects were also evaluated by other researchers who expressed their opinion on whether or not to include them in the list. The obtained list was validated and further enriched by all AE4EU partners.

Since 2014, **a total of 68 projects** related to AE **funded by the European Union** was identified and reported in the final version of the database **in the sheet named "European projects"**.

This sheet is composed by the following columns:

> ID_CORDIS project (grant agreement number), Project_acronym, Project_title, FrameworkProgramme, Workprogramme part, Workprogramme year, ID_Call (Identification ID), Call (title), ID_Topic (Identification), Topic (title), Funding Scheme (type of action), project Start, project End, Project url, Project objective, Total Cost, Project Coordinator (Institution), Coordinator Country, Coordinator Name, Coordinator email, and Participating Countries (ordered in a semi-colon separated list).

The information for each research project was taken from the file "H2020 Projects"[4] and completed by searching and entering the contacts (name and email) of the coordinators of the projects.

The list of **the topics and calls** (within the Horizon 2020 framework) **related to AE research** from the 68 identified projects were reported **in the sheet named "European programmes"**. The list was also enriched including topics and calls from the new working programme 2021-

[4] https://data.europa.eu/data/datasets/cordish2020projects?locale=en

2022 of Horizon Europe where agroecology is explicitly mentioned (no projects have yet been funded).

This "**European programmes**" sheet is composed by the following columns:

Framework Programme, Work programme part, Work programme year, Call ID (Identification ID), Call Title, Topic ID (Identification), Topic title.

2.1.2. Transnational research projects and programmes

The list of AE research project funded by Transnational initiatives and member States reported in the database was obtained consulting: the **ERA-LEARN** and **Organic e-prints** databases.

Since it was not possible to search by keywords in ERA-LEARN database, all the 34400 projects funded within the Horizon 2020 framework and reported in the database were checked. Only 3 projects were instead obtained from Organic e-prints after setting the filters relating to the years (2014 or more) and the English language.

As for the European funded projects, only the transnational projects where agroecology was explicitly mentioned or the projects that were characterized by a strong actor engagement and by criteria addressing at least the level 3 of Gliessman's framework were included in the database.

The obtained list of transnational projects was validated and enriched by all AE4EU partners. **A total of 56 transnational projects** was identified and included in the database in the sheet named "**Transnational projects**".

This sheet contains the following information:

Project Acronym, Project Title, Funding Network, Call, Project Start, Project End, Project URL, Project objective, Project Coordinator (Institution), Coordinator Country, Coordinator Name, Coordinator email, and Participating Countries (ordered in a semi-colon separated list).

The list of **the funding networks and calls related to AE research** from which the identified transnational projects where funded was reported **in the sheet named "Transnational programmes**".

This sheet is composed by the following columns:

Network Acronym, Network Title, Network URL, Network Coordination, Call, Topics of the Call, and Contacts of the leaders of the Calls (names, emails).

2.1.3. National research projects and programmes

As it was difficult to find information in English language on national AE research projects and funding programmes available in the different European Countries, we have directly contacted by email several national funding agencies and bodies of each country in order to obtain these data. A total of **139 national agencies/bodies from 31 Countries** were identified. We asked them to fill in a file with basic information (title, acronym, web site, responsible person, email) on national research projects and funding programmes where agroecology is explicitly mentioned or that refer to issues (for examples within topics such as organic farming, agroforestry, local food system, etc.) where agroecologically sound approaches are declared. In order to facilitate the identification of agroecological approaches in national projects or programmes even if agroecology is not directly mentioned, we have included in the body of the message the definition of what agroecology is for the AE4EU project:

"***Agroecology****?*

Agroecology embraces science, a set of practices and a social movement (Wezel et al. 2009, Agroecology Europe 2017), and applying the concept to whole agri-food systems (Francis et al. 2003, Gliessman 2007). As a ***science****, it gives* ***priority to action research, holistic and participatory approaches, and transdisciplinarity*** *that is* ***inclusive of different knowledge systems*** *(Agroecology Europe 2017). As a* ***practice****, it is based on sustainable* ***use of local renewable resources, local farmers' knowledge and priorities, the wise use of biodiversity to provide ecosystem services and resilience****, and* ***solutions that provide multiple benefits*** *(environmental, economic, social) from local to global (Wezel et al. 2014, Agroecology Europe 2017). As a* ***movement****, it* ***defends smallholders and family farming, farmers and rural communities, food sovereignty, local and short food supply chains, diversity of indigenous seeds and breeds, healthy and quality food*** *(Agroecology Europe 2017). Agroecology is increasingly recognised as a development pathway, which maximises environmental sustainability, producer autonomy, and economic resilience. The general concept of agroecology is quite broad, consequently, the use at the national and European level can be quite diverse with different groups highlighting different elements and topics.*".

AE4EU partners also supported this search at national level providing additional information. The collected data were better analysed reading and in most cases by translating through digital translator information reported in the web sites, in particular in those countries characterized by an excessive number of funded research projects on AE. Many projects, especially those related mainly to organic agriculture but not so strictly to AE (e.g., comparison of efficiency of different organic off-farm fertilizers), were removed from the list. We also checked the information collected for research funding programmes and we removed

from the list many funding programmes aimed exclusively to support farmers' business without any connection with research activities.

At the end, we identified 300 national projects covering 15 Countries. The collected information on the national research projects on AE was reported in the sheet of the database called "**National Projects**" which is composed by the following columns:

> Country, Project title, Project title in English, Project Acronym, Project website, and Project coordinator (name and e-mail).

The data related to the national programmes (23 from 9 countries) were included in the sheet named "**National Programmes**" of the provisional AE4EU database. This sheet contains the following columns:

> Country, Programme Name, Programme Acronym, Programme website, Programme leader/contact person (name, and e-mail).

2.1.4. Institutions

The list of public or private research institutions, organizations, and enterprises involved as partners of the identified European, Transnational and National research projects related to agroecology was reported in the sheet "Participants" of the database. This sheet contains the following columns: Name, Acronym, Country, organization Url.

2.2. Surveys

Three different online surveys (containing both multiple-choice and open-ended questions) were conducted to better understand how agroecology is understood and perceived by research planners and designers in Europe and in the different Countries, and identify opportunities, obstacles and changes needed to improve AE research in Europe. The different questionnaires were structured in order to be able to capture some relevant and conflicting issues and approaches in agroecological research (e.g., sustainable intensification *vs* eco-functional intensification; conventional *vs* organic agriculture; use of genetically modified organisms; multidisciplinary *vs* interdisciplinary; actor diversity and their degree of engagement in the process of knowledge/transdisciplinarity). Many of the questions reported in the different questionnaires concerned these same topics. This was done with the aim to perform a cross-analysis of the responses to highlight both the inconsistencies and the different points of view of the involved research actors.

Although only two surveys were considered and reported as milestones during the writing of the project proposal (**MS2** - Questionnaire for research projects and **MS3** - Questionnaire for research programmes), we decided to also carry out a third type of questionnaire intended for all researchers involved in agroecology.

Therefore, the three different surveys conducted were:

1. **a survey for coordinators of national, transnational and European research projects which deal with agroecology in Europe**.

The coordinators of projects identified in the database were contacted by email and they were asked to fill in a questionnaire. The questionnaire was organized in three sets of questions aimed at acquiring information on: 1) a general overview of the project and the used research approaches to better understand if an integration of different disciplines is carried out and how the research project examines the agri-food system; 2) the actors involved in the projects, in which stages they are engaged, and methods and learning processes implemented to facilitate participation; 3) main lessons learned and challenges addressed by the project.

Originally, a section dedicated to the categorization of the project according to the five levels formulated in the Gliessman (2015) transition theory and based on the **Agroecology Criteria Tool (ACT)** methodology was also included in the questionnaire. This section was removed to reduce the length of the questionnaire whereas the tool was sent to the potential respondents as attachment (to be filled in together with the questionnaire but as optional).

2. **a survey for researchers from academic or other private and public research institutions in Europe involved in agroecology**

The survey was open to any researcher involved in AE. It was widely disseminated through public and private contact mailing lists, networks, and websites. The goal of the survey was to collect information from respondents on their experiences in agroecological research and to gain a better understanding of potential opportunities and obstacles for agroecology. The survey was articulated in three sets of questions related to: a) experiences on research funding; b) experiences on research conducting; c) conclusions and background information.

3. **a survey for leaders of national, transnational and European research programmes which deal with agroecology**

Programme Leaders responsible for the research funding programmes identified in the database were contacted by email and they were asked to fill in the questionnaire. The goal of this survey was to understand how agroecology is perceived by the funding programme designers and how these programmes promote agri-food transformation through agroecology. The questionnaire was articulated in three sets of questions related to: a) a general overview

of the programme; b) main approaches used in the research programme; c) conclusive remarks.

3. Results

3.1. Social network analysis on agroecological research in Europe

With the aim of understanding, mapping, and measuring relationships among European countries involved in AE research projects, a **social network analysis** (**SNA**) was conducted considering all the European (EU) and Transnational (TRANS) projects identified in the database. The network (Figure 1) resulted in **36 nodes** (or Countries) and **486 edges** (links or ties between the nodes). The size of the nodes is proportional to the number of AE research projects coordinated by each country. There is an edge between two nodes when the two countries were partners in the same project. The thickness of the line is proportional to the weight of the edge. This weight represents how many times two countries have cooperated in an AE research project.

France (n=18), Italy (n=18), Spain (n =16), Germany (n =15), United Kingdom (n=14) are the countries that coordinated a greater number of projects, with a strong predominance of the transnational projects for Italy (n=15) and the European projects for France and United Kingdom (respectively, n=13 and n=14). In Spain and Germany, the quantity is instead well divided between European and transnational projects.

Italy and France (weight of70), and Italy and Spain (weight of 67) exhibit more important number of cooperation. On the contrary, there are 106 interaction between countries out of 486, characterized by a only one cooperation (weight of 1). They represent occasional partnerships between two countries.

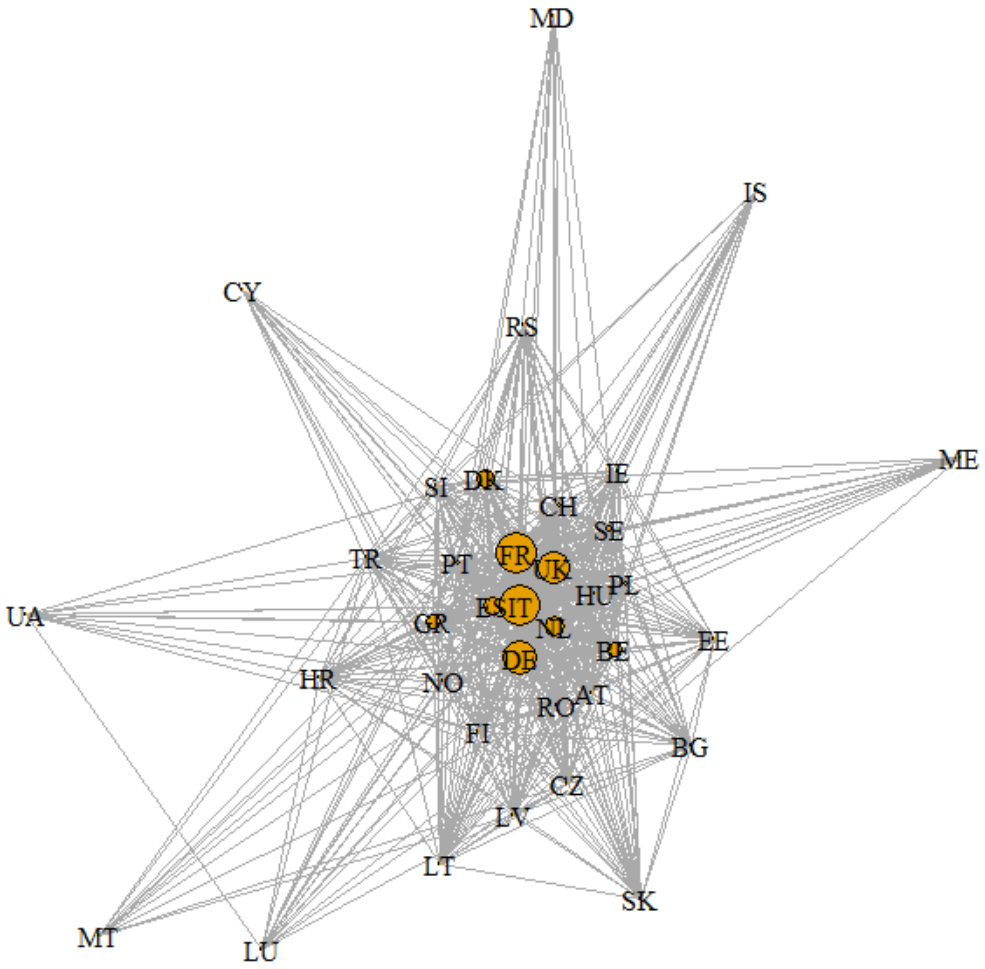

Figure 1. Social Network analysis at Country level on agroecological research projects. The codes of the different Countries are reported in the nodes of the network (AT-Austria; BE- Belgium; BG-Bulgaria; CH-Swiss; CY- Cyprus; CZ - Czech Republic; DE-Germany; DK-Denmark; EE-Estonia; ES-Spain; FI-Finland; FR-France; GR-Greece; HR-Croatia; HU- Hungary; IE-Ireland; IS-Iceland; IT-Italy; LT- Lithuania; LU- Luxembourg; LV-Latvia; MD- Moldova; ME-Montenegro; MT-Malta; NL- Netherlands; NO- Norway; PL-Poland; PT- Portugal; RO-Romania; RS-Serbia; SE- Sweden; SI-Slovenia; SK- Slovakia; TK- Turkey; UA- Ukraine; UK- United Kingdom)

In general, the **density of the social network** (the ratio of the number of edges and the number of possible edges) is **0.78** denoting a very good connection among all countries. Indeed, the the value of this index can vary from 0 to 1 which is obtained when there is at least one connection between all the nodes of the network. The value reported by our network denotes that 78% of the countries have at a minimum one project in common. Its **diameter** (the length of the longest path - in number of edges -between two nodes) is only 2, while the **mean distance** (the average number of edges between any two nodes in the network) is **1.23**. Therefore, also the low values obtained by these two indices (diameter and mean distance) denote a good connection and collaboration between all the countries of the network.

Position of the different countries in the social network was investigated with centrality measures such as **degree and closeness centrality**.

Degree Centrality (DC) reflects the direct relational activity of a node (country) by measuring the number of direct connections each node occupies in a relationship (Wasserman and Koehley, 1994). According to this measure, the node who occupies the central position is the one with the largest number of direct connections with other actors. This measure defines the degree of participation of each country in AE research project networking, its interests and engagement in AE research projects, its attractiveness as a partner and readiness for new partnerships (Divjak et al., 2010). Spain (DC=35), Italy (DC=35), France (DC=34), Netherlands (DC=34), and Portugal (DC=34) have the highest degree centralities, having established direct relations with many countries of the network. On the contrary, Ukraine (DC=12), Moldova (DC=11) and Malta (11) are the countries characterized by fewer direct interactions.

Closeness Centrality (CC) measures how close a node (country) is to the other nodes in the network (Borgatti and Everett, 1997). It is defined by the inverse of the average length of the shortest paths to/from all the other nodes in the graph. Weights are also used for calculating weighted shortest paths. The greater the weight, the shorter the distance among countries. Closeness represents a measure of how long it will take to spread information to all other nodes sequentially. Therefore, CC is a good indicator of the speed of establishing connections, diffusion of innovations and information, and partnership establishment with all involved Countries in the network. Time often plays a major role in the process of finding partners and high closeness centrality indicates that a country is well-connected with other countries and can therefore provide partnership in rather short time (Divjak et al., 2010). Moreover, this measure takes into account both direct and indirect connections. Information can often travel faster through the indirect connections than the direct ones because weights can shorten the path (Newman, 2001). Being this social network on AE research projects characterized by a very good connectivity, all nodes show a similar score going from the highest value (CC= 0.016) for Iceland, Luxembourg and Ukraine to the lowest one (CC=0.07) for Belgium. Although Ukraine is one of the countries with fewer direct connections with other nodes, nevertheless having established strong connections with well-connected countries such as Spain and Italy, it can use these indirect connections and therefore to reach all Countries of the network more quickly. On the contrary, although Belgium has established direct connections with 27 countries, nevertheless it reaches with longest path some of the other nodes of the network. France (CC=0.0138), Netherlands, Germany, Spain, Italy, and Portugal

(all with CC=0.0137) also continue to perform well in this index, showing good direct and indirect connections with all the Counties engaged in AE research projects.

Lastly, we used **the clustering optimal function** of *igraph* **to detect the presence of communities** (also called groups, clusters, or modules) among countries involved in AE research projects. This function calculates the optimal community structure for a graph by maximizing the modularity score over all possible clusters of all sizes. Modularity measures the strength of division of a network into communities. Networks with high modularity have dense connections between the nodes within communities but sparse connections between nodes in different communities. Although with a maximum modality not very high (0.02), this function has highlighted three different groups of countries that create more partnerships among themselves in AE research projects than with other countries. The countries making up the three groups are shown in Figure 2. In general, excluding some exceptions, countries seem to cluster in biogeographic regions [5]. This is reasonable because it allows partners of AE research projects to identify common problems and potential solutions which can be more easily shared and implemented among similar environments.

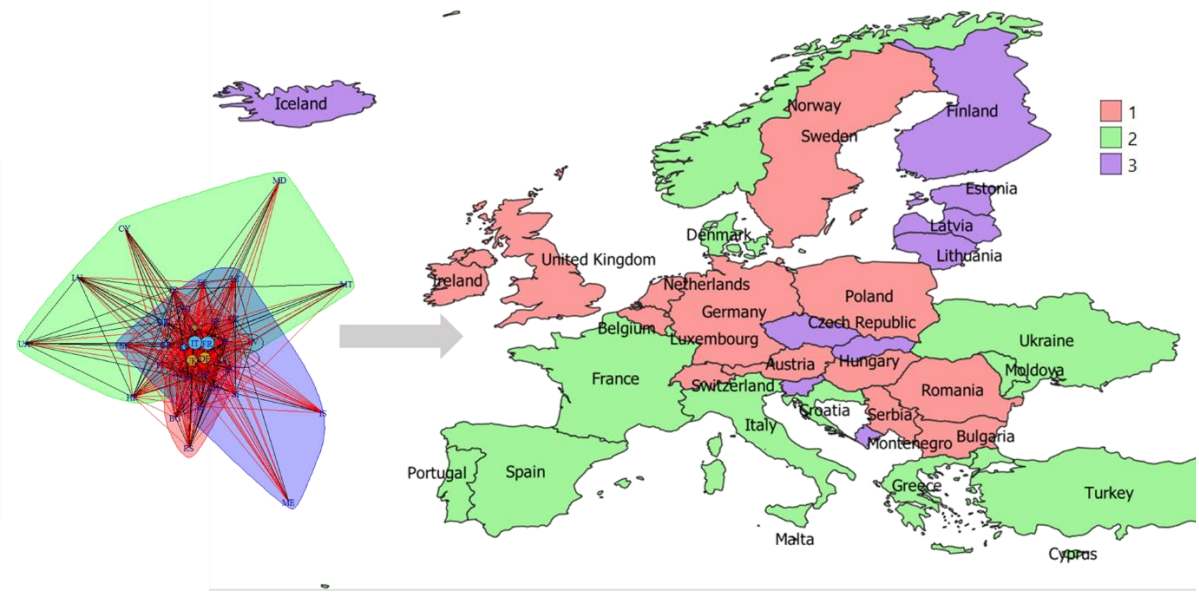

Figure 2. The three groups of countries obtained with the clustering optimal function

Overall, the results of the social network analysis can be useful in drafting strategies at EU, transnational, and national level to increase commitment and participation in agroecological research. In more detail, the above reported evidence could be useful for the EU and national

[5] https://www.eea.europa.eu/data-and-maps/figures/biogeographical-regions-in-europe-2

scientific communities to explore new collaborations and to consolidate/expand the existing ones. Additionally, the SNA outcomes might be exploited by the leaders of international programmes to promote cooperation and spread information and innovation in agroecology more quickly among Europe. Peripherical Countries and research groups can be supported in connecting to more consolidated networks, strengthening cooperation at larger European scale. This is especially true for transnational programming (i.e., EU partnerships) which, by its mission, tend to align the different national strategies and support research activities under an agreed vision in order to overcome fragmentation of public research efforts.

3.2. Survey responses

As mentioned above, the information collected in the database on PPIs was also used to identify people to contact for the three surveys.

Considering **the surveys for the coordinators of AE research projects** identified in the database, and more specifically the answers obtained from the international projects, we received 25% of responses (17 replies out of 68 submissions) at the European (EU) level and 16% (9 replies out of 56 sent emails) at transnational (TRANS) level. At the national (NAT) level we obtained 11% of answers (32 replies out of 300 submissions) from the nine countries reported in the Table 1.

Table 1. Received responses from the coordinators of AE research projects at national level.

Country	Received answers	Sent emails	%
Austria	3	20	15
Finland	11	35	31
Germany	3	8	38
Ireland	2	24	8
Italy	4	21	19
Lithuania	3	47	6
Slovenia	1	4	25
Spain	1	14	7
United Kingdom	4	50	8

Regarding **the surveys for the leaders of research programmes**, at the EU level we contacted the responsible of the Topics of the Calls from which the identified EU projects were funded thanks to the support of some research programme officers of European

Commission and we received 11% of answers (6 out of 53). Regarding the TRANS level, we contacted the leaders of the Calls of the different Networks from which the identified TRANS projects were funded and we received 52% of responses (11 out of 21). At national level we received only 3 answers out of 14 sent emails: 1 from Lithuania and 2 from Estonia.

Considering the **survey open to all researchers involved in AE**, we received 35 responses of which 54% came from Italy (Figure 3).

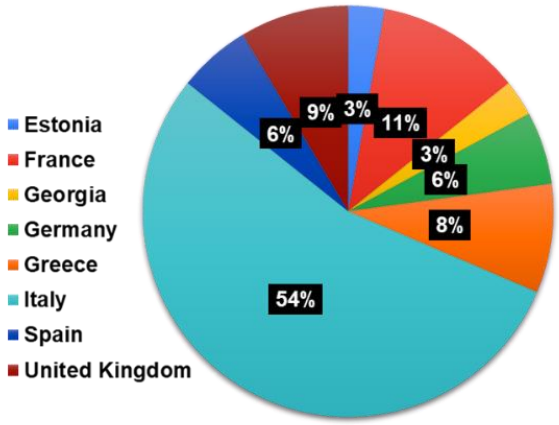

Figure 3. Percentages of responses to the survey for researchers involved in AE from the different countries

3.2.1. Agroecology research projects

At international level, EU projects present a longer **average duration** (3.7 ± 0.9 years) than TRANS projects (2.8 ± 0.7 years). At national level the situation vary a lot. National projects show an average duration of 3 years with the highest values reached by Germany (4.3 years) and United Kingdom (3.5 years).

Regarding the **geographic scales** (local, regional, national, international) **addressed simultaneously by a project**, EU projects show an average of 3 scales with the highest values achieved by the international (addressed by 62% of the projects) and local (50%) scales. TRANS projects address simultaneously less scales (average of 1.5) with the highest values showed by the international (addressed by 78% of the projects) and the regional scale (by 44 % of project). The national projects also show an average of 1.5 facing specifically the national (by 53% of the projects) and regional (47%) scales.

All the **pillars of sustainability** are taken into account by the various research projects with the highest percentages achieved by the environmental and economic dimensions (Figure. 4)

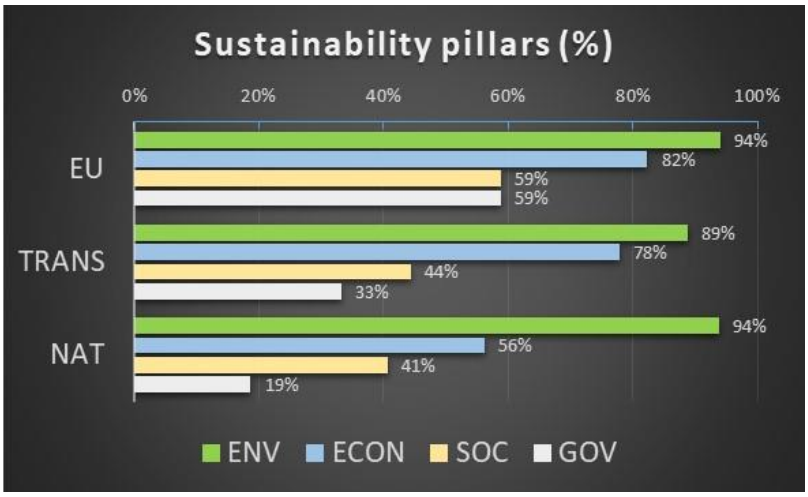

Figure 4. Percentages of sustainability pillars (ENV- Environmental, ECON-Economic, SOC- Social, GOV-Governance) covered by the European (EU), Transnational (TRANS), and National (NAT) research projects.

An important debate that animates the AE scientific community is whether and to what extent **genetic engineering and agroecology are compatible** (Lotz et al., 2020; Bonny, 2017; Giller et al., 2017). Two different visions still coexist. There are researchers favourable to genetically modified organisms (GMOs) when applied to making crops less vulnerable to pests and diseases, others are concerned. Indeed, the latter see GMOs as closely connected to interests innervating the so-called productivist model with the risk of privatizing research results and increasing farmers' dependence on seeds controlled by multinationals. In this survey we investigated whether this double vision on GMOs is also present in the different EU, TRANS, and NAT research projects. At all analysed levels only selective breeding and crossbreeding are implemented in the agroecological research. The only exception is represented by a project in United Kingdom where genome editing techniques are applied.

Another very heated debate concerns the **type of agriculture to be considered in research on agroecology** (Levidow et al., 2014). Should AE researchers mainly support farmers with an already significant commitment to sustainable agriculture, and de-industrialization of the food system, such as organic producers? Indeed, many scientists (but also farmers and consumers) perceived organic farming as a paradigm shift in agriculture (Niggli, 2015). Or should AE researchers be responsive to both these farmers and as well as more mainstream conventional producers? Should AE researchers be critical of certain groups of farmers? These are the questions posed by Buttel in 2003 but which are still relevant today. Again, many researchers see a risk in giving support to mainstream agriculture for the transformative process that agroecology wants to implement and for the possibility of being co-opted by the dominant regime. Considering our identified AE research projects, both organic and conventional production systems are addressed (Figure 5). There are also some research

projects that only face with the conventional system with a higher percentage (25% of projects) at national level compare to other level, determined mainly by Germany and Lithuania.

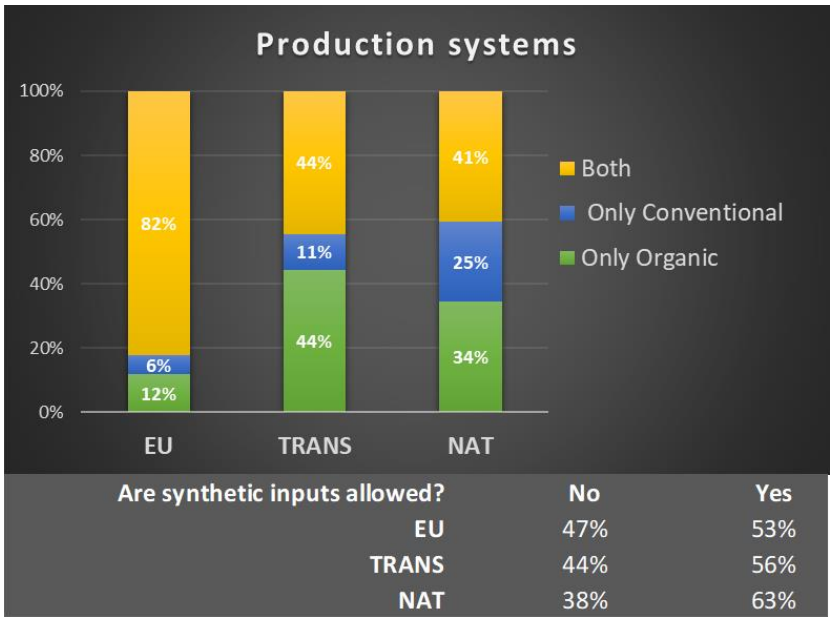

Figure 5. Percentages of the European (EU), Transnatonal (TRANS), and National (NAT) projects addressing only conventional, organic, or both production systems.

However, looking at the percentages of projects where the use of synthetic inputs is allowed, it seems that these do not cover all projects in which the conventional system is present. Therefore, part of the research projects in AE that consider the conventional system, in reality push this system to an organic shift regarding their inputs.

Tensions also occur between **sustainable intensification and ecological intensification**, the former more linked to conventional agriculture with an emphasis on increasing yields without adverse environmental impacts and without the conversion of additional non-agricultural land, the latter aimed at transforming the agricultural system through a knowledge-intensive process that requires optimal management of nature's ecological functions and biodiversity (Levidow et al., 2014). In our survey, sustainable intensification approach was selected and preferred to ecological intensification from only two projects (one at EU and the other at NAT level in Lithuania), whereas ecological intensification was chosen by all others.

Agroecology embraces different disciplines as also highlighted above, since the selected projects simultaneously address different sustainability dimensions. Therefore, it is also relevant to understand **how the integration of different disciplines is carried out in an AE project by the researchers to produce knowledge**. Two different approaches are usually implemented: the **multidisciplinarity** where researchers from different disciplines

collaborate but maintain their disciplinary perspectives, and **interdisciplinarity** where researchers collaborate with higher level of integration of goals and concepts (Mauser et al. 2013). Interdisciplinarity is generally associated to AE research with a transformative role. In our survey, this approach was selected by most of the projects, while multidisciplinarity was implemented only in 1 EU project, and in 4 projects at national level (in Austria, Finland, Ireland, and United Kingdom). The co-creation of knowledge relevant for tangible problem-solving, through the collaboration of **researchers from different disciplines and non-academic actors** is instead defined as **transdisciplinarity** (Mauser et al. 2013; Popa et al., 2015). It is also seen as an interdisciplinarity with the participation of non-academic actors (Fernández González, 2021). Hence, interaction processes with non-academic actors are an important element of transdisciplinary research.

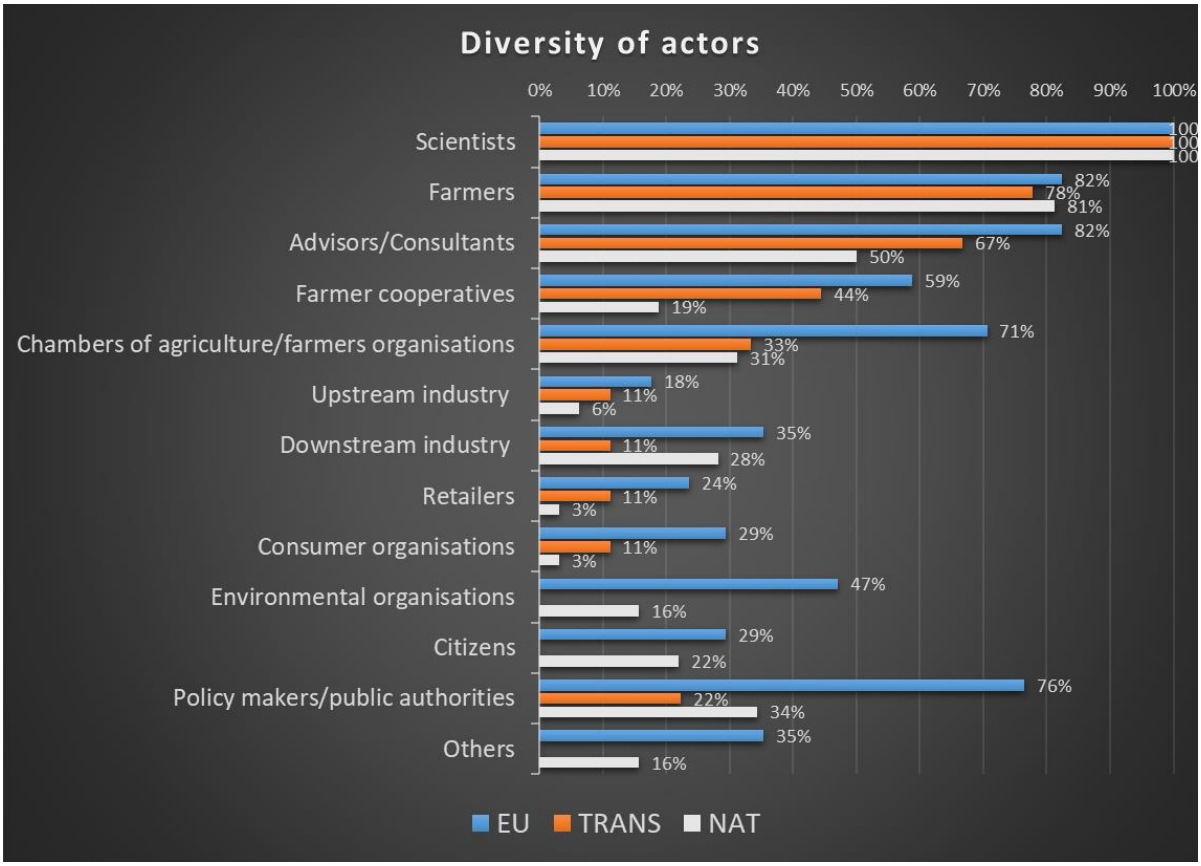

Figure 6. Diversity of actors and their percentages of engagement in European (EU), Transnational (TRANS), and National (NAT) research projects related to Agroecology. Others: Community seed banks, seed savers, bioenergy producers, NGOs providing access to land, ecosystem service users in the local community, Education organisation, Statutory levy board for agricultural development

As it might be expected, excluding the researchers, farmers, their associations, and cooperatives as well as advisors are the actors most involved in the AE projects at all levels (Figure 6), while there is **limited engagement of upstream and downstream value chain actors**. Environmental organizations and policy makers are mostly present in EU research

projects. The average number of different types of actors involved in AE projects is 7 for EU, and 4 for both TRANS and NAT. The lowest number of actors is present in Lithuania and Italy (Table 2). And specifically, in most of the projects in Lithuania, only researchers seem to be involved since the other actors are present in only 33% of the projects.

Table 2. Diversity of actors and their percentage of participation in national projects from the different respondent countries

Actors	Austria	Finland	Germany	Ireland	Italy	Lithuania	Slovenia	Spain	United Kingdom
Average number of different types of actors	5	4	5	5	3	3	4	5	4
Scientists	100%	100%	100%	100%	100%	100%	100%	100%	100%
Farmers	67%	91%	100%	100%	100%	33%	100%	100%	50%
Advisors/Consultants	67%	45%	67%	50%	25%	33%	100%	100%	50%
Farmer cooperatives	0%	18%	0%	50%	0%	33%	0%	100%	25%
Chambers of agriculture / farmers organisations	67%	18%	67%	100%	0%	33%	0%	0%	25%
Upstream industry	0%	9%	0%	0%	0%	0%	0%	0%	25%
Downstream industry	0%	45%	33%	50%	25%	0%	0%	0%	25%
Retailers	0%	0%	0%	0%	0%	0%	0%	0%	25%
Consumer organisations	0%	9%	0%	0%	0%	0%	0%	0%	0%
Environmental organisations	67%	9%	0%	50%	25%	0%	0%	0%	0%
Citizens	33%	27%	33%	0%	0%	33%	0%	0%	25%
Policy makers/public authorities	67%	36%	33%	50%	0%	0%	100%	100%	25%
Others	0%	27%	33%	0%	0%	0%	0%	0%	25%

We investigated the **interaction with non-academic actors in the co-creation of knowledge** along **the different phases of the research project** using a classification proposed by Schneider and Buser (2018). These authors identified **six different degrees of interaction** describing different modes of non-academic actor involvement in research and what roles are attributed to them (Table 3). Lower degrees (1 and 2) refer to cases in which non-academic actors are mere recipients of knowledge and they are just informed about research actions and results. Medium degrees (3 and 4) refer to cases in which non-academic actors are consulted to express their knowledge (e.g. interview or focus group situations). Higher degrees (5 and 6) refer to modes of collaboration in which knowledge is truly co-produced and the research process is co-shaped with non-academic actors (e.g. reciprocal learning between scientists and non-academic actors, integration of several perspectives). **Transdisciplinary is only achieved in these higher degrees**. The degrees of interaction can be identified in the different

phases of the research (Lang et al., 2021): a. phase "*Framing the problem and research goal*" where the most relevant problems that research has to address are defined; b. "*Knowledge production*" where the new knowledge is produced: c. phase "*bringing results to fruition*" where the new knowledge is re-integrated into scientific and societal practice.

Table 3. Different degrees of actor interaction over the three phases of research (from Schneider and Buser, 2018).

Interaction degree		Problem-framing and goal-definition phase	Knowledge-production phase	Bringing-new knowledge to fruition phase
Co-production	6	Problem and goal co-framed by scientists and stakeholders; main elements of the proposal are codesigned	Co-production of knowledge including deliberation and integration of all relevant stakeholder perspectives regarding main project elements	Co-producing main project outcomes and jointly constructing follow-up structures/actions, and engaging in societal learning processes
	5	Problem and (overall) goal co-framed by scientists and stakeholders; some elements of the proposal are codesigned	Co-production of knowledge including deliberation and integration of all relevant stakeholder perspectives regarding some project elements	Co-producing some project outcomes and/ or jointly constructing follow-up structures/actions, and/or engaging in societal-learning processes
Consultation	4	Problem and goal framed by scientists; broad consultation of stakeholders leading to minor thematic adjustments of the proposal dealing with different stakeholders' perspectives and priorities	Knowledge production by scientists, taking into account various stakeholders' knowledge and perspectives. A wide range of stakeholders are consulted, but the knowledge is structured according to the scientists' concepts	A wide range of stakeholders is consulted to discuss research results. The stakeholders' perspectives influence final interpretations and recommendations
	3	Problem and goal framed by scientists; consultation of some stakeholders leading to minor thematic adjustments of the proposal	Knowledge production by scientists; some key stakeholders are informed and consulted for fine-tuning	Stakeholders are informed and final results and recommendations are jointly discussed
Informing	2	Problem and goal framed by scientists; a few stakeholders are informed about the project and feedback is encouraged. Stakeholder interactions influence logistical issues, but not project goals	Knowledge production by scientists; some stakeholders are informed and given an opportunity to provide feedback, e.g. in individual meetings, but they have hardly any influence on knowledge production	Stakeholders are informed about final results by means of articles and at meetings that offer a chance to clarify questions
	1	Problem and goal framed by scientists; a few	Knowledge production by scientists; some stakeholders	Stakeholders are informed about final results by means of articles

	stakeholders are informed about the project. Stakeholder interactions do not influence the proposal	are informed about the status of the project	in professional journals or newspapers

Considering the responses to our survey (Figure 7), the higher degrees of non-academic actor involvement are better achieved by EU projects in all the phases of the research. On the contrary, TRANS projects show the highest percentages in the lower degrees of interaction where information or consultation of the actors are implemented. The responses at the national level are instead very variable and depend on country considered. On average, the highest degrees are reported by Germany in all phases of the research, the lowest by Italy and Lithuania (Table 4).

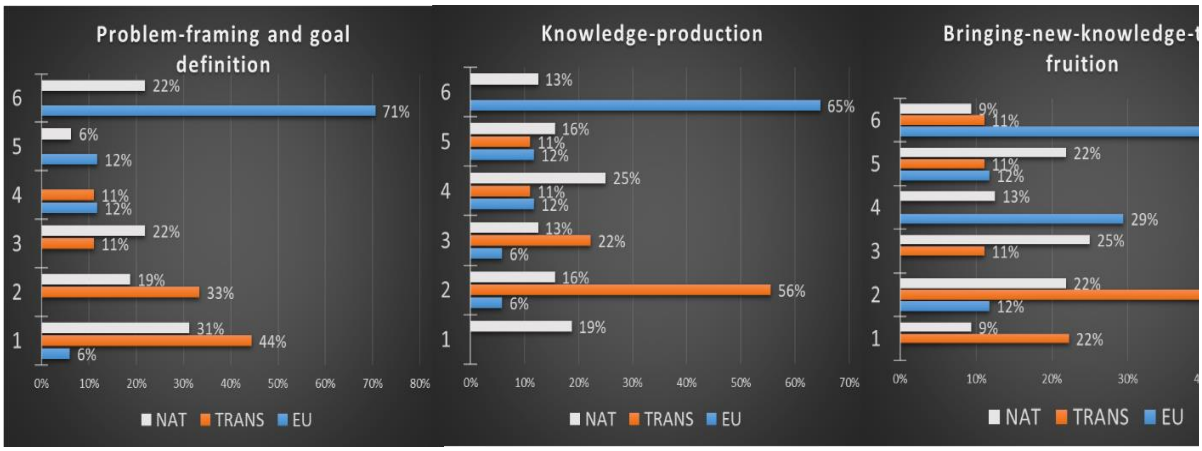

Figure 7. Degrees of actor interaction (from 1-lower to 6 -higher interaction) over the three phases of research in European (EU), Transnational (TRANS), and National (NAT) projects related to agroecology

Table 4. Mean values of degrees of actor interaction (from 1-lower to 6 -higher interaction) over the three phases of research in national projects from the different respondent countries

	Problem-framing and goal definition	Knowledge-production	Bringing-new-knowledge-to-fruition
Austria	3.3	3.0	4.0
Finland	3.4	3.8	3.5
Germany	4.3	4.7	4.0
Ireland	2.0	4.0	4.0
Italy	1.8	2.0	2.8
Lithuania	2.7	2.0	3.0
Slovenia	3.0	3.0	3.0
Spain	1.0	5.0	3.0
United Kingdom	3.0	3.5	3.5

Agroecological problems are complex and require the engagement of several (academic and non-academic) actors to define meaningful research questions for local environmental and socio-economic contexts in order to achieve a real transformation of agri-food systems. The incorporation of non-academic actor knowledge and experience into the research process can support scientific efforts by providing a locally embedded broader view on agroecology (Biber-Freudenberger et al., 2018). This process can sustain appropriate research agendas with outcomes and outputs relevant and adoptable by local communities, thus increasing innovation impacts. Transdisciplinary and co-learning processes seem to be key (although often difficult) elements for the research in AE by most of the respondents as many of their comments and lessons learned go in this direction:

"*Great care may need taken to help ensure a "better balance" of science/academic goals with the transdisciplinary and business elements. Many academics, simply, do not understand (or are unwilling to accept) what transdisciplinary is, and how this can help direct their research effort towards being more impactful. Equally, there is real concern among some academics, that real data gathers of biological/ecological systems are becoming a rarity*." (EU)

"*Researchers' and scientists' targets and how their work is evaluated is in contrast with the type of work and activities needed to engage effectively with stakeholders. For example, the importance of academic publications is still too great to allow scientists to dedicate more time to stakeholder engagement*" (TRANS)

"*Involvement of stakeholders in co-creation (so called multi actor approach) is useful and facilitates the impact but it is at the same time very challenging due to the differences in understanding how the science is run*" (EU)

"*Transnational projects are difficult when trying to be truly collaborative, but we learned a lot and dissemination and collaboration with stakeholders becomes stronger*" (TRANS)

"*Most results were unexpected. Strategy in project conception is essential to target longer term goals. Important to make room to different levels of engagement. Important to work on adding value to farmers' observation and translate them in scientifically usable (i.e. replicable, generalisable) data. Major feedback from farmers is their learning the importance of the co-operation between farmers in collective experimentation, as opposed to individually testing on each one's farm*" (NAT – United Kingdom)

"*Food system redesign is a highly complex, diffuse co-creation process*" (NAT-Finland)

"*Importance of synergies with relevant other current and future initiatives with remits in policy, science and society dialogues on topics relevant for agro-ecological transitions and sustainability of farming and food systems and rural areas. Importance of considering actors*

who are hard to reach to ensure Multi-Actor Platforms reflect the principals of just transitions." (EU)

"*The intended learnings are about the strategic decision processes and supporting analysis used by a variety of organisations in developing biological systems (eg design of consumer products, waste infrastructure, farming regimes)"* (NAT – United Kingdom)

"*We learned the importance of systems thinking as opposed to holistic: being pragmatic in addressing an apparently small sub-component and understanding it in depth is essential as a tangible entry-point into the whole system (If always trying to tackle the whole system, the risk is to not obtaining actionable results). For instance, starting from the need to help farmers choose variety, participating farmers ended up using the project experience to make more strategic, higher-level decisions. I think this strategy in projects conception, stemming from action-research, is too often neglected in agroecology research and must be encouraged: it is not the "what" to study, it is rather the "how" that makes "agroecology". It is not "understand how you farmers should redesign every system", it is rather "getting the strategic skills to redesign*" (NAT – United Kingdom)

New ways of knowledge production based on the involvement and interaction of non-academic actors (from the entire agri-food system) into the research process are therefore fundamental to carry out the transformative role of agroecology, and to increase the impact of the research, enhancing territoriality and control at the local level. Specifically, a transdisciplinary research environment should be also strengthened and emphasized by research funding programmes to address serious societal challenges on the ground (Schneider et al., 2019)

Living labs - LLs are increasingly gaining ground as an approach to be used in research projects to strengthen transdiciplinarity and innovation (McPhee et al., 2021). In our survey, LLs are present in 53% of EU, 22% of TRANS, and 44% of NAT projects. However, according to our experiences, transdisciplinarity in LLs is sometimes reduced to a "buzzword" and the mere involvement of actors is reduced to a consulting or informative process rather than a deep integration of knowledge. This also seems to happen in our survey where the higher degrees of actor interaction (degrees 5 or 6) are reported only by 56% of total projects with LLs in "Problem-framing and goal definition" phase, by 48% in "Knowledge production" phase, and by 24% in "Bringing-new-knowledge-to-fruition" phase (Table 5).

Table 5. Percentage of projects with LLs at European (EU), Transnational (TRANS), National level (NAT), and in total (TOT) characterized by higher degrees (5 or 6) of actor interaction over the three phases of research in national projects from the different respondent countries.

	Problem-framing and goal definition	Knowledge-production	Bringing-new-knowledge-to-fruition
EU	89%	89%	67%
TRANS	0%	0%	50%
NAT	43%	29%	57%
TOT	56%	48%	24%

Therefore, further efforts must be made to identify those elements that an LL must have in order to truly guarantee the co-production and co-creation of knowledge thus allowing a more rapid diffusion of agroecological innovation on a territory.

Research Infrastructures - RIs are also seen as instruments that have large potential to contribute to amplifying agroecology in Europe. RIs are used/developed by 33% of projects at all levels (18% for EU, 44% for TRANS, and 38% for NAT) and remain available even after the end of the projects for 95% of cases.

Projects' coordinators were also asked to **identify how their projects support agri-food transformation through agroecology in Europe** according to a set of issues (Table 6) proposed by the ACT tool and related to the FAO' 10+ elements of Agroecology (FAO, 2018). These elements are embedded within the 5 levels of food system change proposed by Gliessman (2015).

Table 6. List of issues proposed by the survey for the coordinators of projects

Gliessman's levels	FAO elements	Issues
Lev 1	Efficiency	Improving approaches focused on increasing/maintaining yield and reducing external input use
Lev 2	Recycling	Strengthening practices that close cycles, drive the recycling of nutrients, biomass, and water within production systems
	Regulation and balance	Optimizing the biophysical mechanisms and interactions within farming systems to boost natural regulation processes, including pest regulation, and to temper disturbances through alternative practices that substitute toxic inputs

Lev 3	Synergies	Carefully designing diversified system and integration of elements in the system to optimize biological synergies
	Diversity	Optimize the vertical, temporal, spatial diversity of species and genetic resources
	Resilience	Increasing the capacity to recover from disturbances including extreme weather events
Lev 4	Circular and solidarity economy	Reconnecting producers and consumers, prioritizing local markets and short food circuit, and supporting local economic development
	Healthy and cultural food	Supporting healthy food production and consumption, and cultural identity tied to landscapes and food systems
	Co-creation and sharing of knowledge	Promoting innovation co-created through participatory processes and context-specific knowledge
Lev 5	Human and social value	Improving rural livelihoods, equity, and social well-being (dignity, inclusion, and justice) by building autonomy and adaptive capacities
	Responsible governance	Promoting responsible, effective, transparent, accountable, and inclusive governance mechanisms at different scales

The highest percentages of responses were obtained for Efficiency (67% of total projects), Synergies (50%), Local economy (43%), and Co-creation and sharing of knowledge (66%). The different percentages obtained for the different levels (EU, TRANS, NAT) are shown in figure 8, while those relating to the different respondent countries in Table 7.

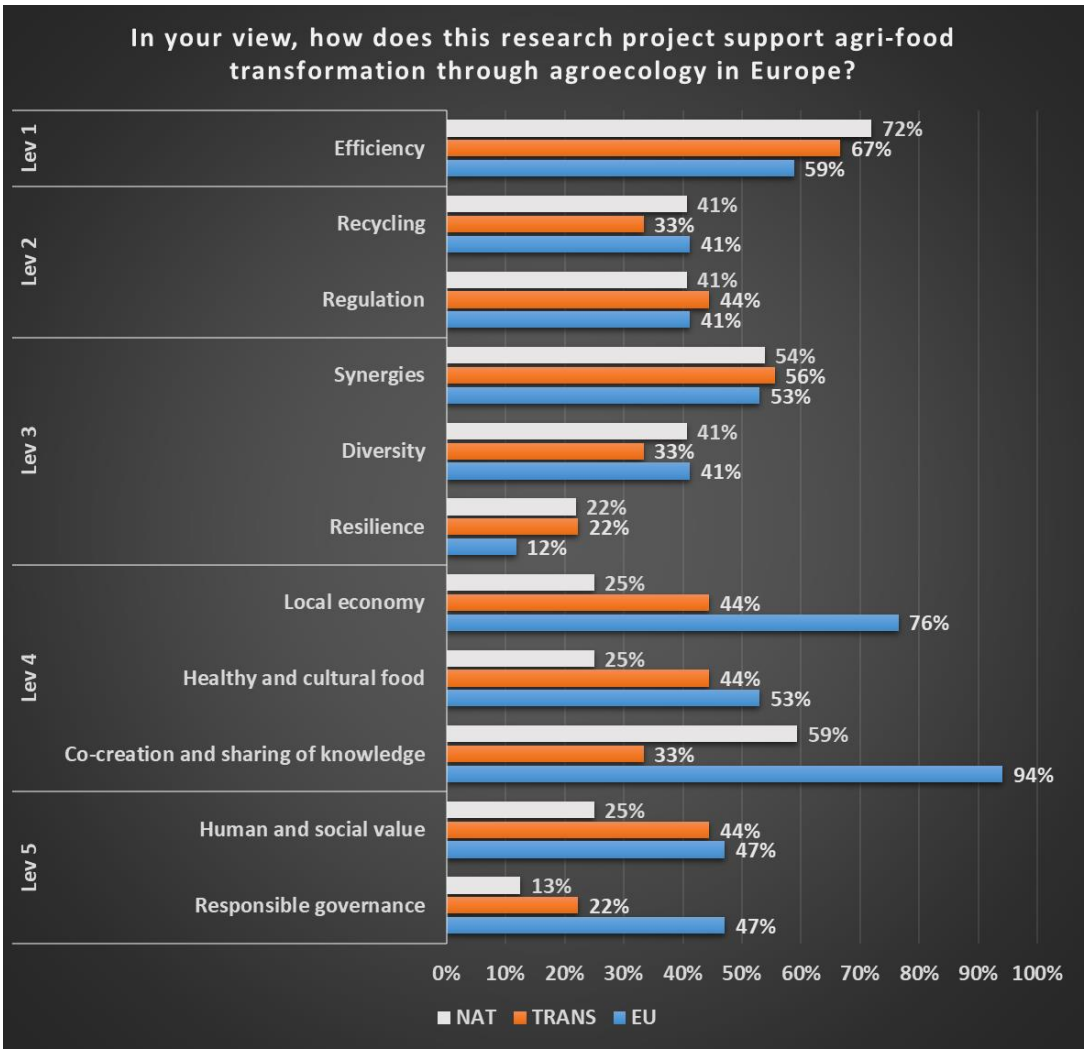

Figure 8. Percentages of issues promoted by European (EU), Transnational (TRANS), and National (NAT) research projects to support agri-food transformation in Europe through agroecology. Issues are related to the FAO' 10+ elements of Agroecology and embedded within Gliessman levels of food system change.

Table 7. Percentages of issues (related to the FAO' 10+ elements of Agroecology and embedded within Gliessman levels of food system change) promoted by national projects from the different respondent countries to support agri-food transformation in Europe through agroecology.

	Austria	Finland	Germany	Ireland	Italy	Lithuania	Slovenia	Spain	United Kingdom
Lev 1 - Efficiency	33%	73%	33%	50%	100%	100%	100%	100%	75%
Lev 2- Recycling	67%	55%	0%	50%	0%	67%	100%	0%	25%
Lev 2 - Regulation	33%	27%	67%	50%	50%	67%	0%	0%	50%
Lev 3- Synergies	33%	45%	100%	100%	50%	67%	0%	0%	0%
Lev 3 - Diversity	67%	36%	33%	50%	50%	33%	0%	0%	50%
Lev 3 - Resilience	33%	27%	0%	50%	0%	0%	0%	0%	50%
Lev 4 - Local economy	67%	36%	0%	0%	25%	0%	0%	100%	0%

Lev 4- Healthy and cultural food	67%	27%	0%	0%	50%	0%	0%	100%	0%
Lev4- Co-creation and sharing of knowledge	33%	73%	67%	50%	75%	67%	0%	100%	25%
Lev 5- Human and social value	0%	55%	33%	0%	0%	0%	0%	100%	0%
Lev5- Responsible governance	0%	18%	33%	0%	0%	0%	0%	100%	0%

Using information obtained with the survey, documents available on the web-sites, and considering the ACT files received by the respondents (23 out of 58) with the list of the addressed criteria (De Longe et al., 2016), **projects were classified in 4 categories according to the ACT tool methodology** (Biovision and IPES Food, 2020): a. **Incremental change** - projects addressing solely the level 1 and/or 2 proposed by Gliessman; b. **Agroecological transformation** - where projects are also engaged with level 3; c. **Systemic** - where in addition to level 3, level 4 and/or 5 are also addressed; d. **Social enablers** – with the engagement only with level 4 and/or 5. The obtained classification is reported in Figure 9. The highest percentage for EU is achieved by the "Systemic" category (53% of projects), denoting the greater complexity that characterizes these projects which address the whole agri-food system, while TRANS and NAT (respectively, 67% and 69%) are predominantly made up of the "Agroecological transformation" category focusing more on the redesign of farm and agroecosystems. The "incremental change" addressing exclusively the level 1 and/or 2 of Gliessman is only present at national level, specifically in same project of Italy, Lithuania, Slovenia, and United Kingdom. On the other hand, Finland stands out for the complexity of its AE research having 45% of the projects in the "Systemic" category.

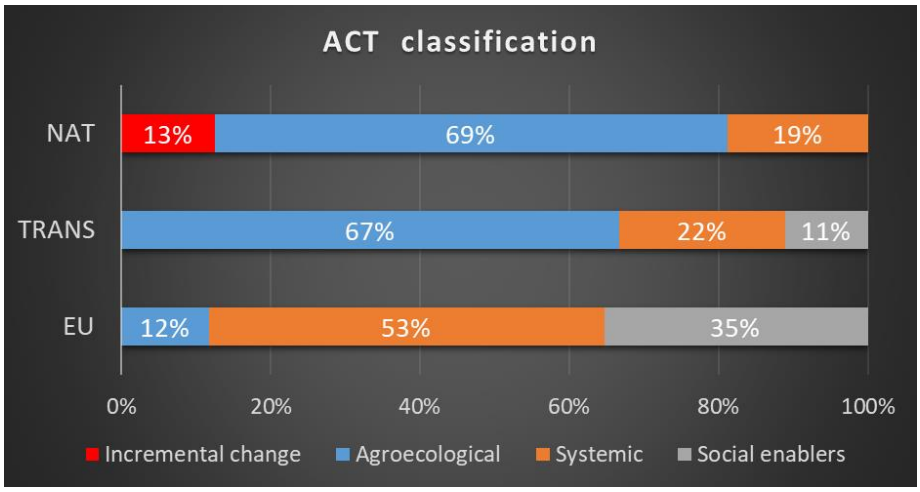

Figure 9. Percentages of the 4 categories identified according to the ACT tool methodology obtained for the European (EU), Transnational (TRANS), and National (NAT) research projects

With the aim to summarize relevant information and find interesting patterns in the data, we carried out a principal component analysis (PCA) using the package FactoMineR (Lê et al., 2008) and considering all EU, TRANS, and NAT respondent projects. We created a dataset with the following quantitative variables:

- **Problem_framing** (degree of interaction with actors at the phase "*Framing the problem and research goal*"): from 1 to 6;
- **Knowledge_production** (degree of interaction with actors at the phase "*Knowledge-production*'): from 1 to 6;
- **KnowledgeTofruition** (degree of interaction with actors at the phase "*Bringing-new-knowledge-to-fruition*'): from 1 to 6;
- **LL** (presence of living lab): 1 for Yes, 0 for No;
- **RI** (presence of research infrastructure): 1 for Yes, 0 for No;
- **N_SUST** (number of sustainability pillars addressed by the project): 1 to 4;
- **Duration** (duration of the project) in years;
- **N_Scales** (number of spatial scales addressed by the project): 1 to 4;
- **Classification** (according to ACT tool methodology): 1 for "*Incremental change*", 2 for "*Agroecological trasformation*", 3 for "*Systemic*", 4 for "*Social enablers*";
- **N_actors** (number of different types of actors involved in the project);
- **Budget** (total budget of the project)

The PCA (Figure 10) showed that the first component explained 42.6% of the total variance. This dimension was mainly positively associated with Knowledge_production (0.87), N_actors (0.82), and Knowledge_to_fruition (0.80). The second component of the

PCA explained 12.6% of the overall variance and it was manly positively correlated with the duration of the project D (0.73) and partially with the budget (0.50).

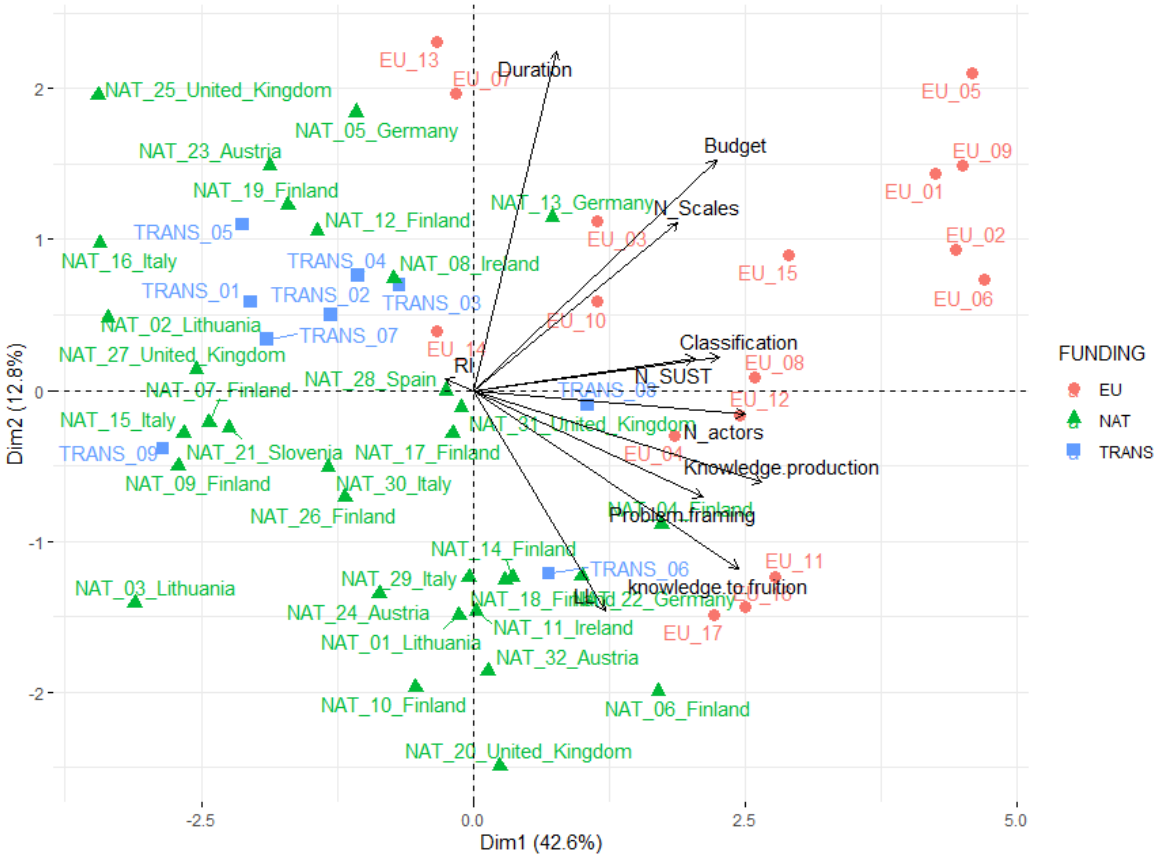

Figure 10. Principal component analysis obtained for the European (EU), Transnational (TRANS), and National (NAT) research projects respondent to the survey.

Concerning the observations, there is a clear distinction of EU projects from others. In fact, they are positioned on the right side of the graph characterized by greater complexity (more actors, more sustainability pillars, and addressing the whole agri-food system) and by the implementation of transdisciplinary approaches in various phases of the research. Differently, TRANS projects seem to be positioned in the upper left quadrant which is characterized by a lower degree of involvement of the actors (i.e., information, consulting). NAT projects mostly occupy the left side of the graph, placing itself in the upper or lower quadrant also depending on the duration of the project. However, no well-defined cluster between the different countries at national level is evident.

3.2.2. Researchers involved in AE

Unlike the survey for the research projects, no selection of respondents was made for this survey. It was open to all researchers involved in AE. Most respondents (57%) were over 50 years, 29% were aged between 35 and 50, and only 9% were under 35. Respondents varied widely in the number of years they have been working in agroecology: 54% of respondents were in later career stage in AE (> 10 years), and 23% were both in the middle (5-10 years) and earlier stage (<5 years). Most of the respondents (83%) are related to agronomic sciences (in particular soil sciences and plant pathologies), 11% are from economic sciences, and 6% from social science. 89% work in public research organisation or academia/university, 11% in private research or non-governmental organisations.

Some issues investigated in the previous survey were also explored in this survey. A 5-point Likert scale was used to ask the perceived **importance of some themes and approaches for AE,** where 5 represented the most importance for the respondents and 1 the least one. Percentage of the responses are reported in Figure 11. From the values of the 5-point Likert scale (1-5), the mean (μ) and the coefficient of variation in percentage (CV%) of responses were also calculated.

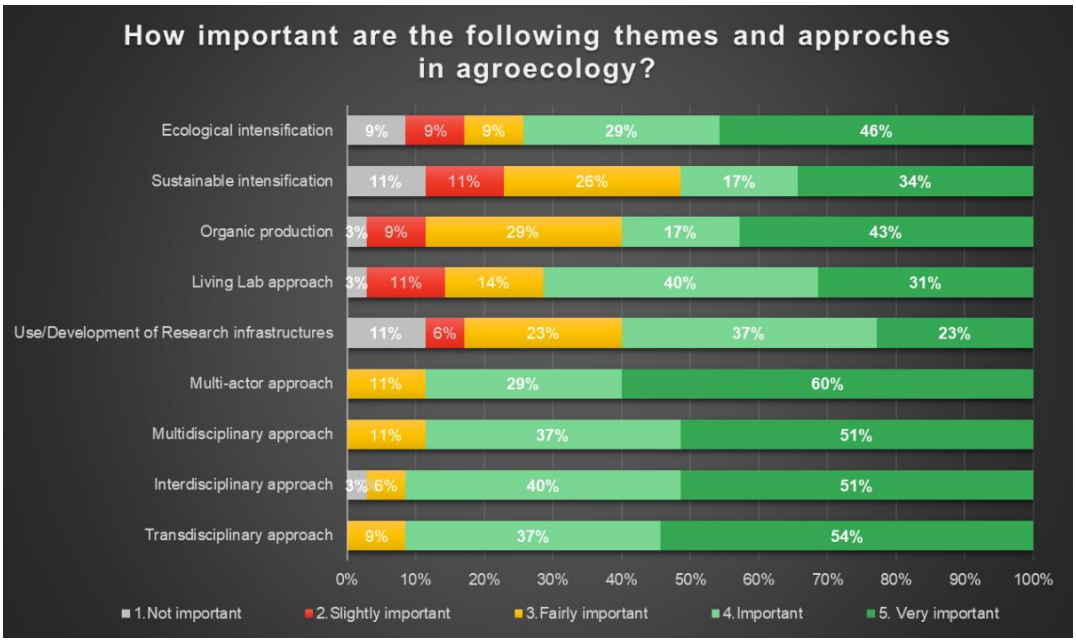

Figure 11. Percentages of importance (according to 5-point Likert scale) of themes and approaches in agroecology for the respondent researchers

Ecological intensification showed a very slightly higher degree of preference (μ=3.9, CV= 33%) than **sustainable intensification** (μ=3.5, CV= 39%), while **organic production** was considered very important for AE only by 43% of respondents reaching a mean value of

importance of 3.9. **LLs** (μ=3.9, CV= 28%) and **RIs** (μ=3.5, CV= 35%) were also considered quite important to support research in agroecology. No substantial difference is also evident between **multidisciplinary** (μ=4.4, CV= 16%) and **interdisciplinary** (μ=4.4, CV= 19%), while the importance of actor engagement in AE for respondents is shown by the highest means and lowest CV values obtained by **transdisciplinary** and **multi-actor approach** both with μ=4.5 and CV= 15%.

Most of the AE studies carried out by respondents concern field (71%), farm (83%), and territorial scales (63%), while the value chain is weakly addressed (Figure 12).

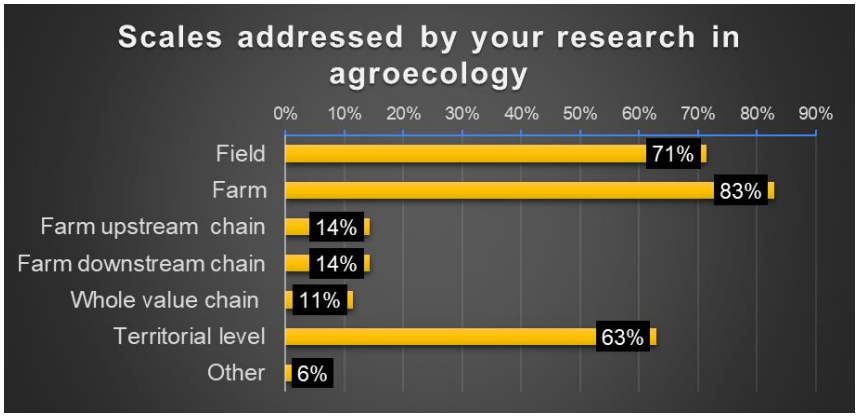

Figure 12. Scales addressed by the respondent researchers in their research in agroecology. Other: Landscape, watershed

This is also confirmed by the **type of actors engaged** in the studies (Figure 13), where there is a few limited participation of upstream and downstream value chain stakeholders. In average, the different type of involved actors per research is quite high (n=7) and the obtained percentage are totally in line with the responses provided in the previous survey by the coordinators of AE research projects.

Farmers and other non-academic actors involved in the research are mainly identified by previous collaborations (83%), by a request coming from the same actor (54%) or through a stakeholder analysis (43%). Considering the three phases of the research (Figure 14), interaction with farmers and other non-academic actors takes place principally in the initial phase for the definition of the problem that research has to address. Monitoring and evaluation of engagement of farmers and other non-academic actors throughout the duration of the research was carried out only by respectively 45.7% (for farmers) and 31.4% (for other actors) of the respondents. Monitoring and evaluation are mainly done through periodical meetings, participative workshops, evaluation surveys, constant contacts and self-reflection.

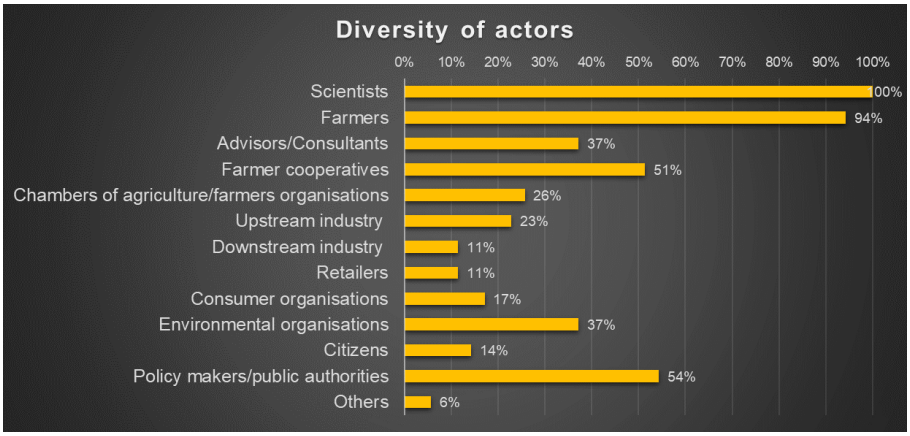

Figure 13. Diversity of actors and their percentages of engagement in AE research carried out by respondents. *Others: Professional organisations (organic assoc., breeding assoc. etc)*

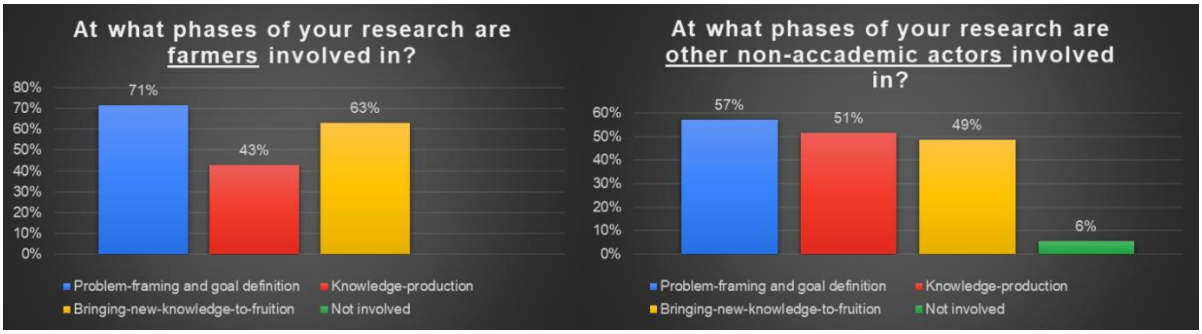

Figure 14. Percentages of interaction with farmers and other non-academic actors over the three phase of a research carried out by respondent

In general, willingness of farmers (μ=3.5, CV= 30%) and other non-academic actors (μ=3.4, CV= 31%) was considered somewhat satisfactory by researchers according to the 5-point Likert scale, while the level of satisfaction regarding rewards/promotion/recognition for this type of participatory research was slightly low (μ=2.5, CV= 41%).

Many comments provided by the responders highlight the importance to engage farmers and other food actors in research related to AE, even if there are some difficulties and barriers:

"*Interest from stakeholders (particularly the not-farmer ones) is a crucial aspect, sensibilization activities should be implemented to increase stakeholders' awareness they can become actors of the food systems*"

"*Time to involve in and human resources devoted to such participatory research*"

"*Collaboration with farmers need time and energy to be kept alive, this dimension of maintaining the collaboration "alive" and "dynamic" is often underestimated in the project funding and not rewarded in term of research*"

"*Involvement of farmers (and farmers interest to PAR activities) is easier the further away they are from large markets and the more remote the rural areas*"

"*Very difficult to engage actors not directly connected with the production*".

Respondents were also asked to identify how their research support agri-food transformation through agroecology in Europe according to the same set of issues proposed in the previous surveys (Table 6) which are related to the FAO' 10+ elements of Agroecology embedded within the 5 levels of Gliessman. Also, in this case the results are totally in line with those obtained in the previous survey (Figure 15). Indeed, the highest percentages of responses were obtained for Efficiency (69% of total projects), Synergies (57%), Local economy (51%), and Co-creation and sharing of knowledge (57%). Both surveys therefore suggest strengthening the issues related to resilience (Lev 3) and the social and governance aspects (Lev 5) given that they obtained the lowest percentages.

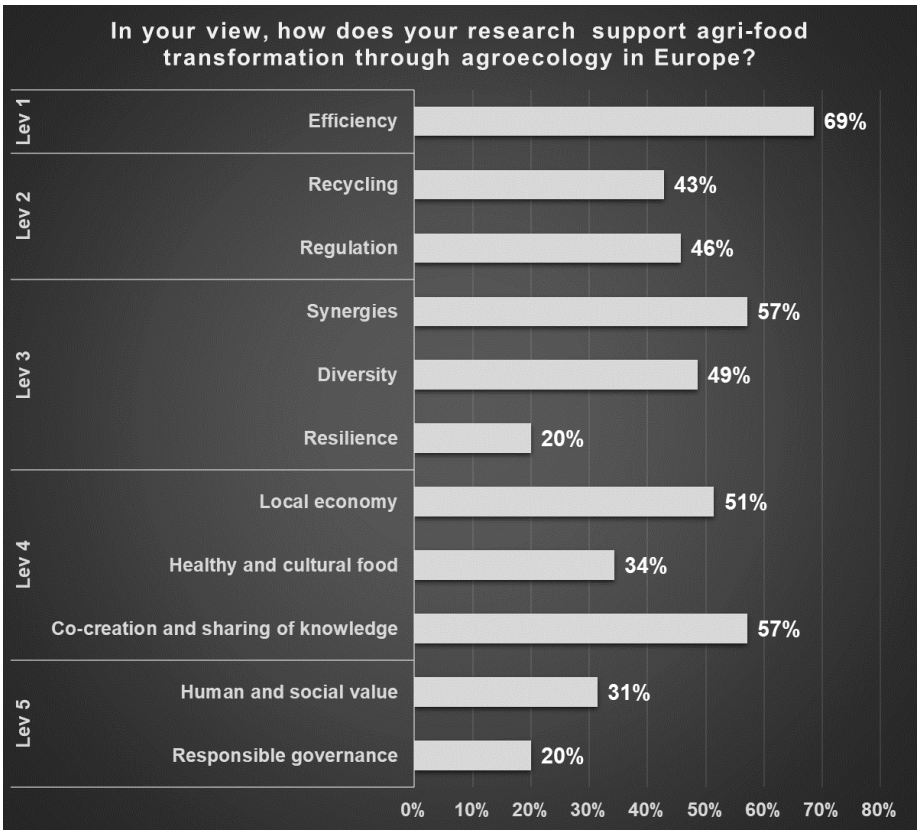

Figure 15. Percentages of issues promoted by respondents in their researches to support agri-food transformation in Europe through agroecology. Issues are related to the FAO' 10+ elements of Agroecology and embedded within Gliessman levels of food system change.

Using the addressed issues, the research approach implemented in agroecology by the respondents was classified in the 4 categories proposed by the ACT tool methodology already used in the previous survey: a. **Incremental change** – research addressing issues related to

solely the level 1 and/or 2; b. **Agroecological transformation** – when the research also implements issues of level 3; c. **Systemic** - where in addition to level 3, level 4 and/or 5 are also addressed; d. **Social enablers** – where research addresses issues related only to the levels 4 and/or 5. The obtained classification is reported in Figure 16. There is a higher percentage of cases classified as "incremental" (20%) than in the previous survey (11% only in the national projects) and therefore more researchers who are "potentially" closer to the non-transformative role of agroecology. However, researchers implementing an approach of re-design of the farm/agroecosystem (26%) and the whole agri-food system (43%) represent the majority.

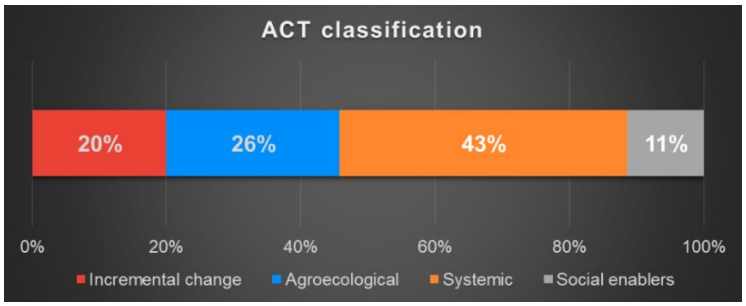

Figure 16. Percentages of the 4 categories identified according to the ACT tool methodology obtained for the research approach on agroecology implemented by the respondents

In addition to the implementation of the research, some questions of the survey also addressed **experiences on research funding in agroecology**. Respondents obtain funding for their AE research principally from NAT (695) and EU (63%) programmes (Figure 17). Less funds derive from TRANS funding programmes (31%) which must be for this reason further promoted among researchers involved in AE. The creation of the new partnership on agroecology ("*Accelerating farming systems transition: agroecology living labs and research infrastructures*") goes in this right direction.

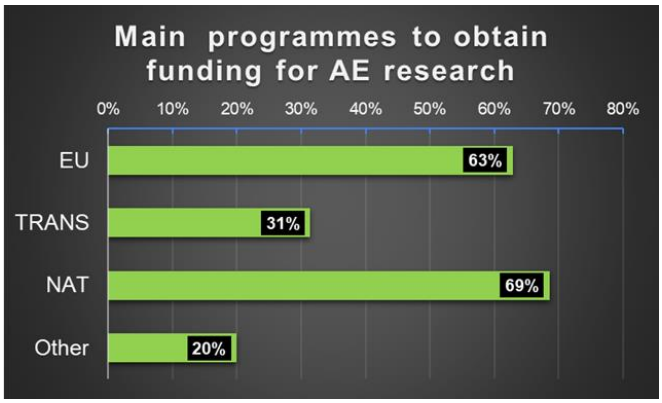

Figure 17. Source of funding for AE research of the respondents. *Other: Rural development programmes; Foundations; PRIN-PSR*

When asked "*Do you think that the current funding programmes to which you apply to, are rightly designed to support agri-food transformation through agroecology or do you think that some changes are necessary to strength and accelerate this transformation in Europe*?" only 54% of respondents answered "*No, some changes are necessary*". Specifically, they mainly require a greater duration of the projects, better integration of social aspects together with the other components, attention not only to producers (especially smallholder farmers) but to the different actors of the food system and, obviously, less bureaucracy, change in reporting methods and indicators:

"*More agroecology, longer projects, adding new partner every year, including small farmers as micro-business in Innovation actions, more social and food system aspects*"

"*Funding advocacy and implementation of input independence strategies throughout in the food systems, and particularly, the productive smallholder farming sector, should be a priority*"

"*Programmes are still too siloed: integration of all dimensions of AE are needed (environmental, social, economic, political - or across the various principles of AE, e.g. 13 HLPE principles)*"

"*Less bureaucracy, more access to private companies, separation of projects based on TRLs*"
"*Increased premiality, proportionally to the agrecological intensification introduced*"

"*Yield increase paradigm still too much in some calls*"

"*The topic of the programs are good. But to be funded, projects need more skills in writing and speaking bureaucratically language, than scientific skills and practical potential. Too much formalisms. Projects are written with the evaluation sheet in mind, not with innovation potential in mind. Projects are judged as good when they contain all the wizard words, rather than having real science and innovation potential. Deliverables, milestones and all of the like, are designed so a non-expert project evaluator (officer) can check the boxes and judge the good progress of the project. Its real impact, however, is another story. The bureaucrats are leading the game*"

"*A more interdisciplinary approach should be applied*"

"*Projects with longer duration (over five years) in fact agro-ecological transition requires long term processes*"

"*Better integration of social sciences*"

"*At a minimum, we need consultancy and technical assistance programs for businesses in the food supply chains, especially farmers and processors, to be implemented through the*

establishment of communities of practice and living labs, information and communication campaigns aimed at consumers to gain awareness of sustainable diets and consumption styles, their ability to induce changes in the production system in view of greater sustainability by interacting with producers"

"*Agroecology and ecological intensification need to be embedded into the one-health concept and clearly focussed*"

"*Programmes/calls should be build considering the possibility to enable the direct participation of stakeholders (e.g. farms, organization) as partners*"

Give more importance to roots, belowground ecosystem services, crop diversification, breeding and holobiont concepts"

"*Specific funding calls for agroecology are rare*"

"*Individual projects should not become too big (more than 2-5Million) otherwise only the big organisations will be able to coordinate such a consortium. In contrast, smaller budgets would allow smaller organisations and consortia to profit from the programmes*"

"*More flexibility on how to spend the budget, based on need*"

"*In agroecology one cannot ignore the needs of food system operators and consumers/civil society for which the bottom-up approach should be implicit. These needs should then be collected by researchers, representatives, and institutions who, together with operators in the food supply chains, consumers and other stakeholders, develop the research project, enriching it with any elements that may be overlooked and in any case shared by all*"

"*In the end it is often very narrow reserach that is funded, rarely a really broad approach is funded and if so it remains shallow*"

"*Farmers engagement in the project need to have funds since they are key part of the project*"

Lastly, researchers were asked the importance of some changes in programmes to better support research in agroecology according to a 5-point Likert scale (Figure 18). "*Increase of the maximum funding amount per project*" (μ=3.5, CV= 26%) and "*Increased use of cross-cutting or joint calls*" (μ=3.8, CV= 28%) were considered the least important needed changes, while "*Increase of the duration of the projects funded by the programme*" (μ=4.2, CV= 22%) "*Recognition of a lump sum for costs incurred in stakeholder engagement and consultation during the co-framing of the proposal*" (μ=4.2, CV= 20%), and "*Introduction /presence of methods capable of guaranteeing the flexibility of project actions based on the dynamics of the contexts*" (μ=4.2, CV= 21%) were the most relevant.

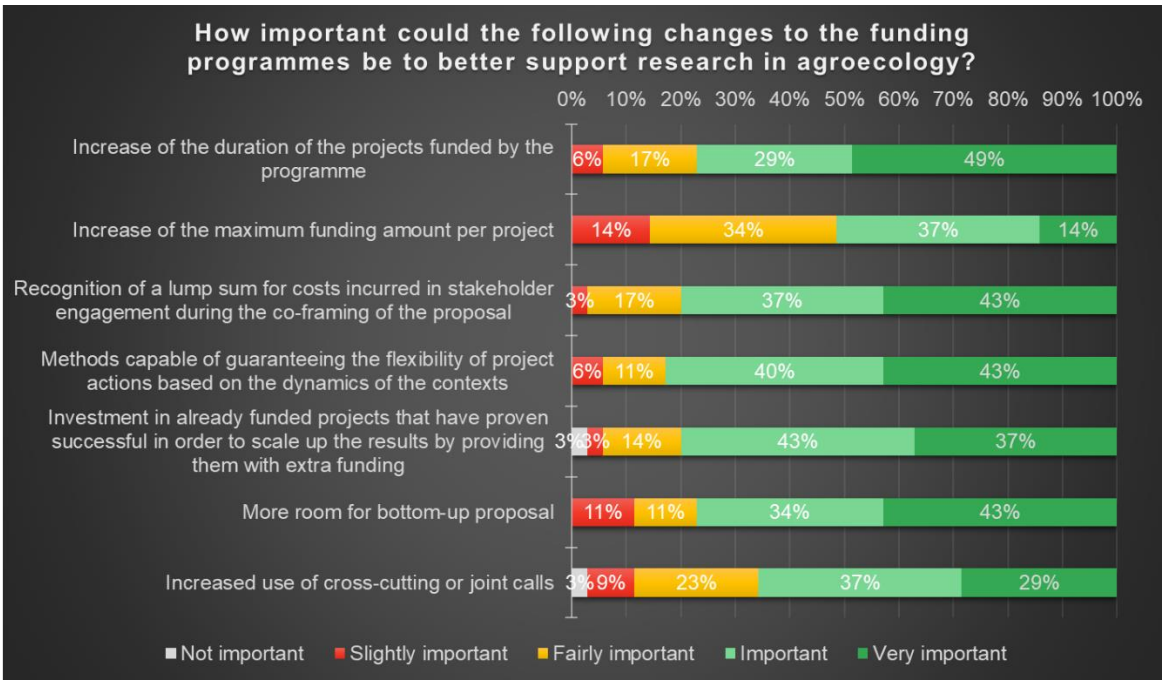

Figure 18. Percentages of importance of changes (according to 5-point Likert scale) for the respondents to implement in programmes funding research in agroecology

3.2.3. Programmes funding AE research

The last survey was for the leaders of the EU, TRANS, and NAT programmes funding research in agroecology. Some issues investigated in the previous surveys were also explored in this survey to compare results, even if the overlap of the responses received by the programmes and projects financed by these programmes is not complete.

We explored if some **themes and approaches** were considered by the different funding programmes and, if so, how important are them for AE research (using a 5-point Likert scale) according to the point of view of the leaders of those programmes. Results are reported in Figure 19. No difference of importance was found between **ecological intensification** (μ=4.6, CV= 11%) and **sustainable intensification** (μ=4.7, CV= 39%) in all (EU, TRANS, and NAT) programme levels. **LLs** (μ=4.2, CV= 23%) and **RIs** (μ=4.3, CV= 18%) were also considered important to support research in agroecology, even if they are not present in 38% of the programmes. No substantial differences were also found between **multidisciplinary** (μ=4.9, CV= 4%) and **interdisciplinary** (μ=4.8, CV= 7%) even if the former is not considered by 11% of the programmes (in particular NAT and EU levels). **Transdisciplinary (**μ=4.1 and CV= 29%) obtained a lower value compared to the other disciplinary approaches and it was not considered at all by 11% of the programmes (mainly NAT and EU).

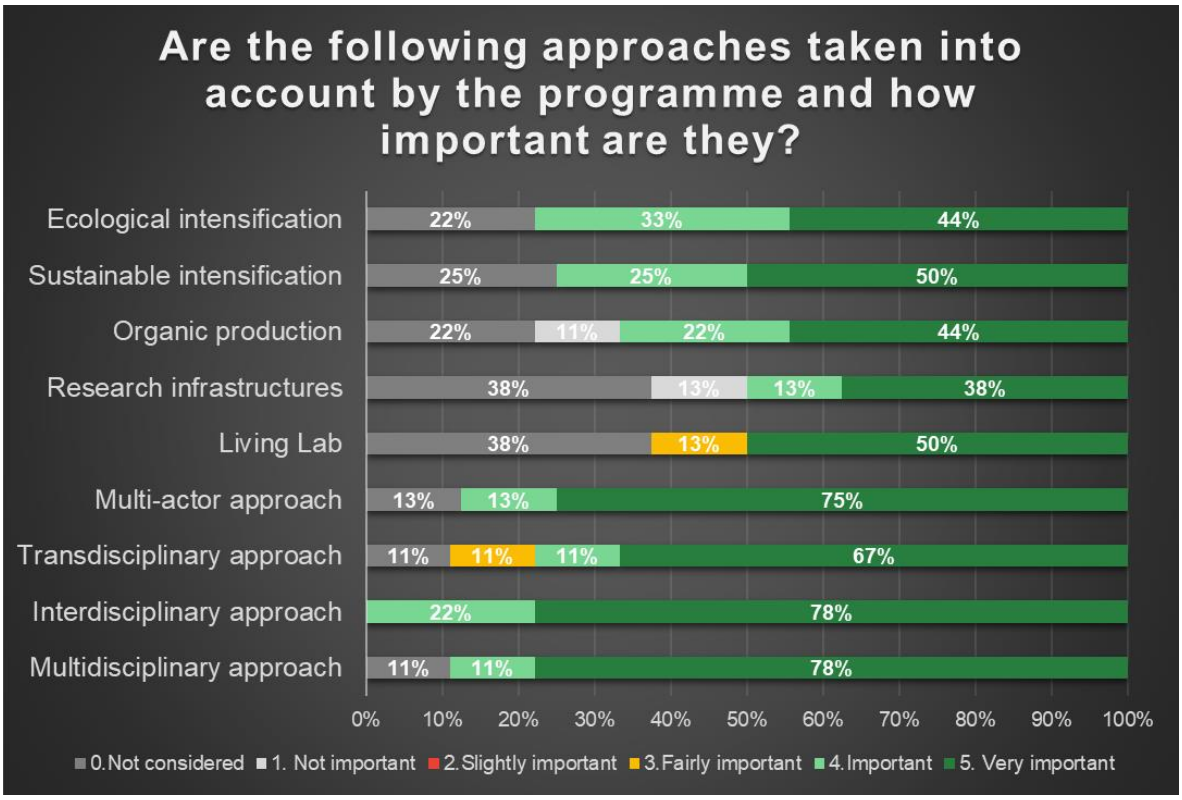

Figure 19. Percentages of importance (according to 5-point Likert scale) of themes and approaches in agroecology for the respondent programme leaders

All the **pillars of sustainability** are taken into account by the various funding programmes (except for the social dimension in the respondent Estonian and Lithuanian programmes) with the highest percentages achieved by the environmental and economic dimensions (Fig. 19) as reported by the survey for the research projects funded by these programmes. Although the overlap of the responses obtained from the programmes and projects funded by these programmes is not total, social dimension seems to be better addressed by TRANS programmes than it was reported by the survey for the research projects.

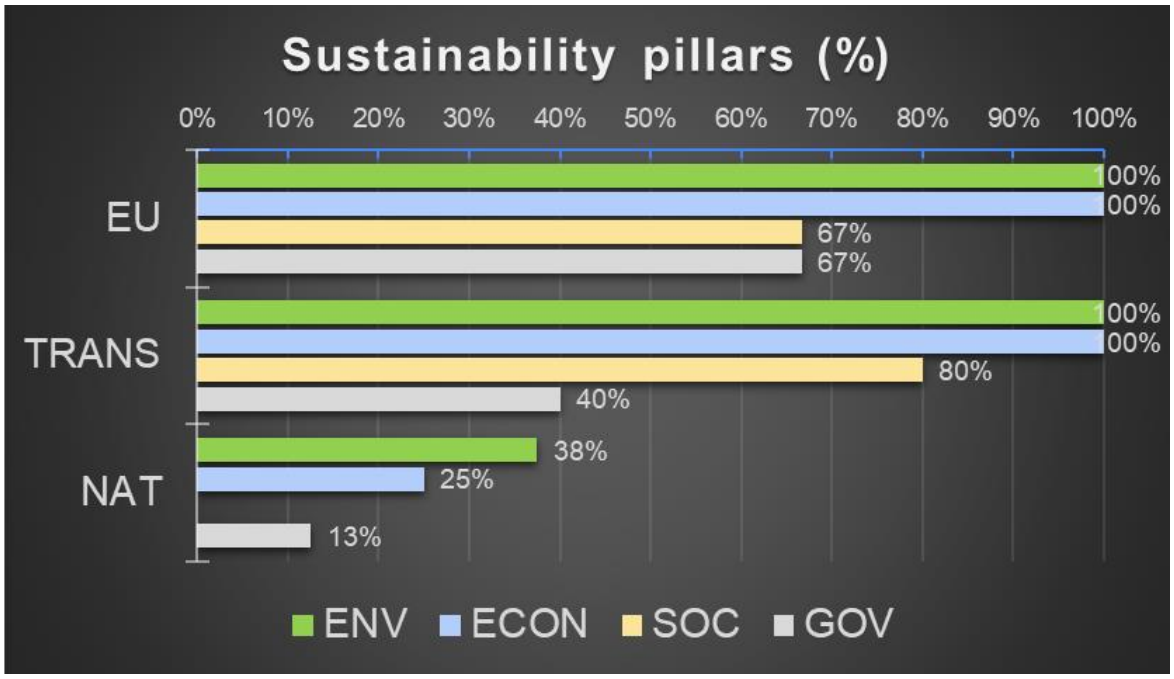

Figure 20. Percentages of sustainability pillars (ENV- Environmental, ECON-Economic, SOC- Social, GOV- Governance) covered by the European (EU), Transnational (TRANS), and National (NAT) research funding programmes.

Unexpectedly, despite the complexity highlighted by the research projects at EU level, according to the responses provided by the leaders of these programmes, EU programmes seem to be very focused on achieving few **sustainable development goals - SDGs** (Figure 20), specifically Climate Action (33 % of EU programmes) and Life and Land (67%). On the other hand, the TRANS and NAT programmes embrace multiple goals including economic and social ones. A special note should be made for the TRANS programmes which also aim to address Gender Equity, an issue that is relevant to agroecology (Zaremba et al., 2021). This issue was not mentioned by any research projects even in the answers provided in the ACT file where there is a specific criterion on gender inclusion.

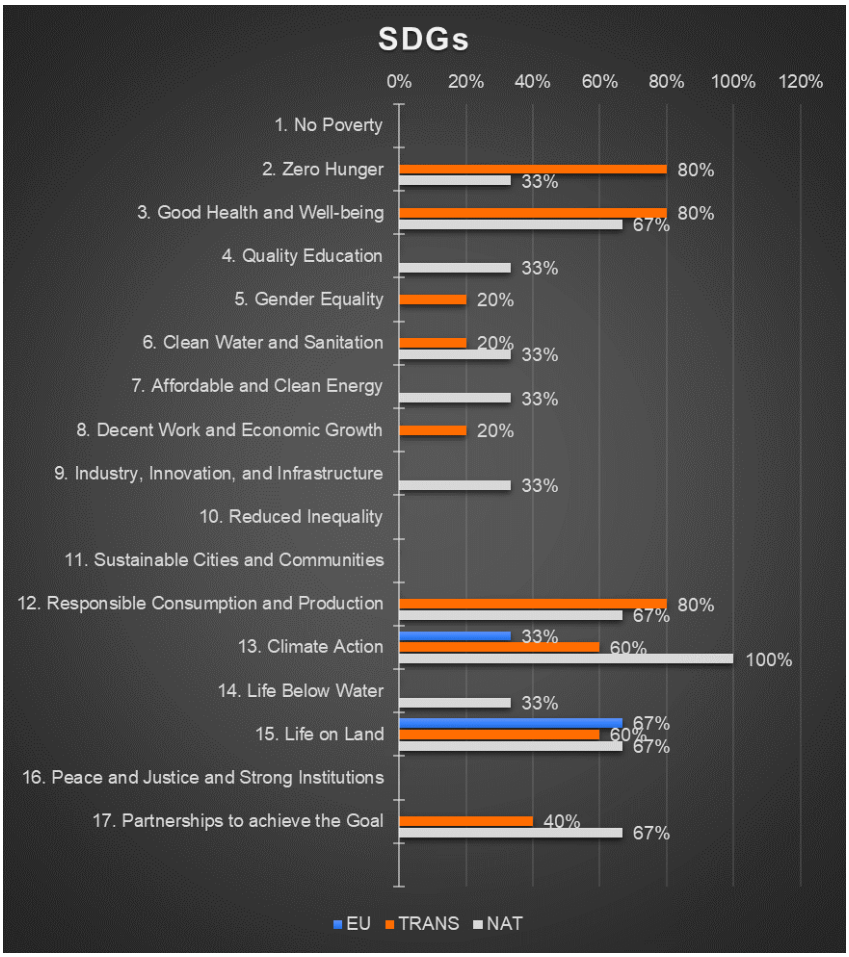

Figure 21. Percentages of sustainable development goals (SGDs) addressed by the European (EU), Transnational (TRANS), and National (NAT) research funding programmes

We also investigated **the diversity of actors** considered by the programmes and their importance according to the point of view of programme leaders (Figure 22). The results are in line with those of the previous EU and national surveys (Canali et al., 2020). Indeed, the less relevant actors for the research in agroecology seem to be those of the value chain (specifically Upstream actors - μ=3.8, CV= 30% - and Retailers - μ=3.7, CV= 37% - respectively, not taken into account by 25% and 14% of programmes; Downstream actors - μ=3.4, CV= 37%), Environmental organisations (μ=3.6, CV= 27%), and Citizens (μ=3.4, CV= 33%). No relevant differences were found between the different levels (EU, TRANS, NAT) of the funding programmes.

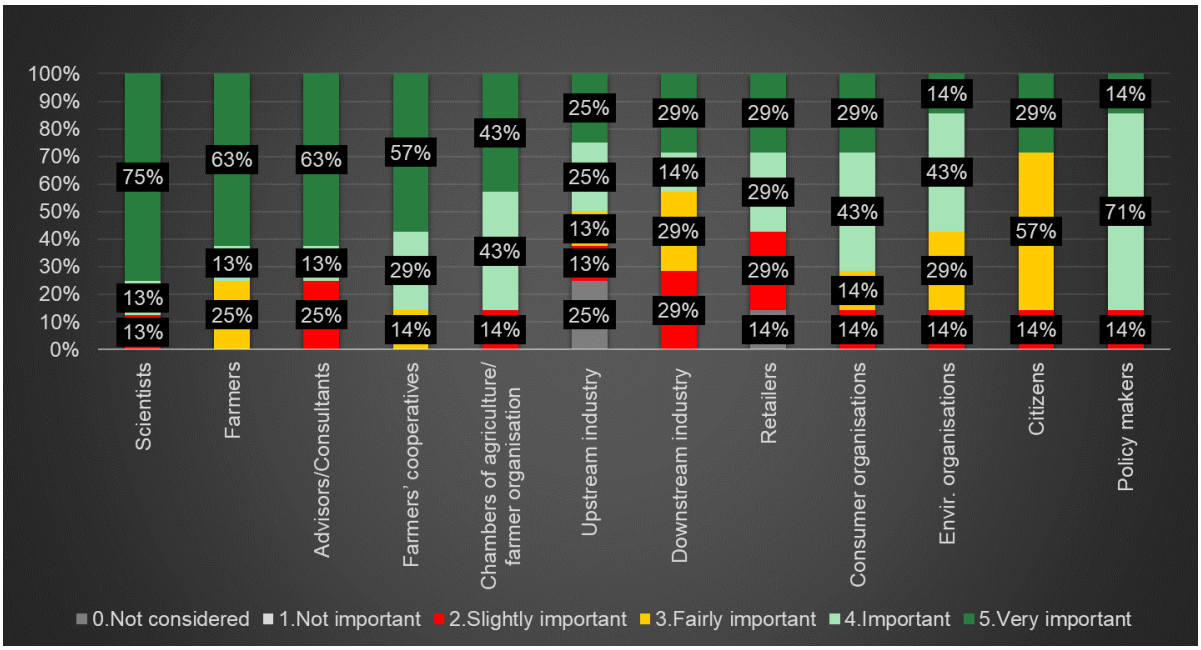

Figure 22. Diversity of actors and their percentages of importance (according to 5-point Likert scale) of engagement in AE research for the respondent programme leaders.

Respondents were also asked to identify how the funding programmes support agri-food transformation through agroecology in Europe according to the same set of issues proposed in the previous two surveys (Table 6). Results are partially in line with those obtained in the previous surveys. Funding programmes seem to address principally issues related to level 1 and level 2 of Gliessman's food changes. Indeed, considering all EU, TRANS, and NAT programmes, the highest percentages of responses were obtained for Efficiency (82% of total projects), Recycling (73%) and Regulation (64%). Level 3 was mainly addressed by TRANS and NAT programmes, and the same happens for Level 5 (Figure 23).

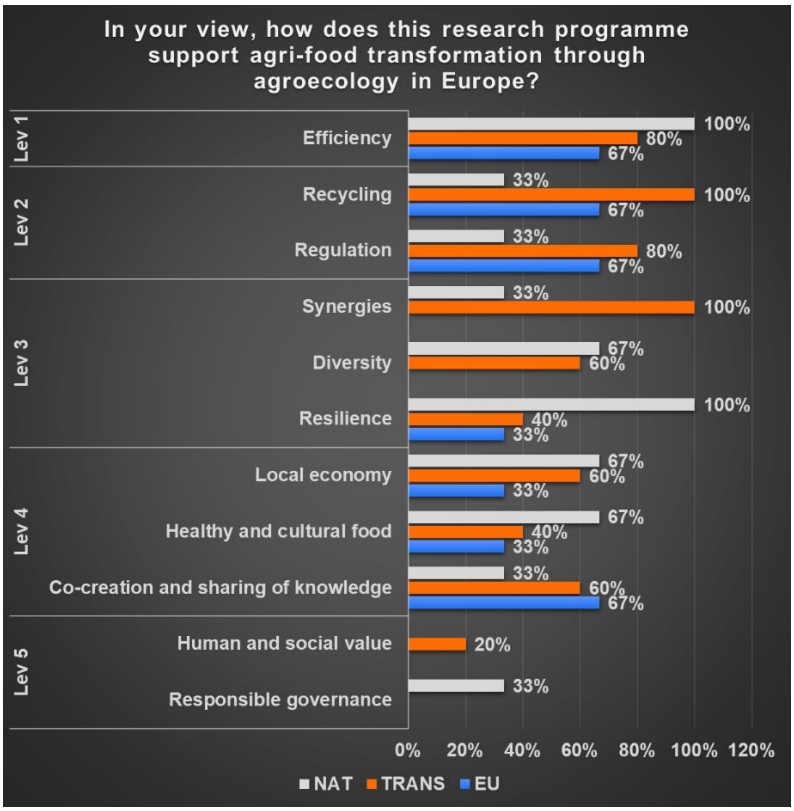

Figure 23. Percentages of issues promoted by European (EU), Transnational (TRANS), and National (NAT) funding programmes to support agri-food transformation in Europe through agroecology. Issues are related to the FAO' 10+ elements of Agroecology and embedded within Gliessman's levels of food system change.

Lastly, respondents were asked the importance of some changes (the same reported in the survey for the researchers) needed in funding programmes to better support research in agroecology according to a 5-point Likert scale (Figure 24).

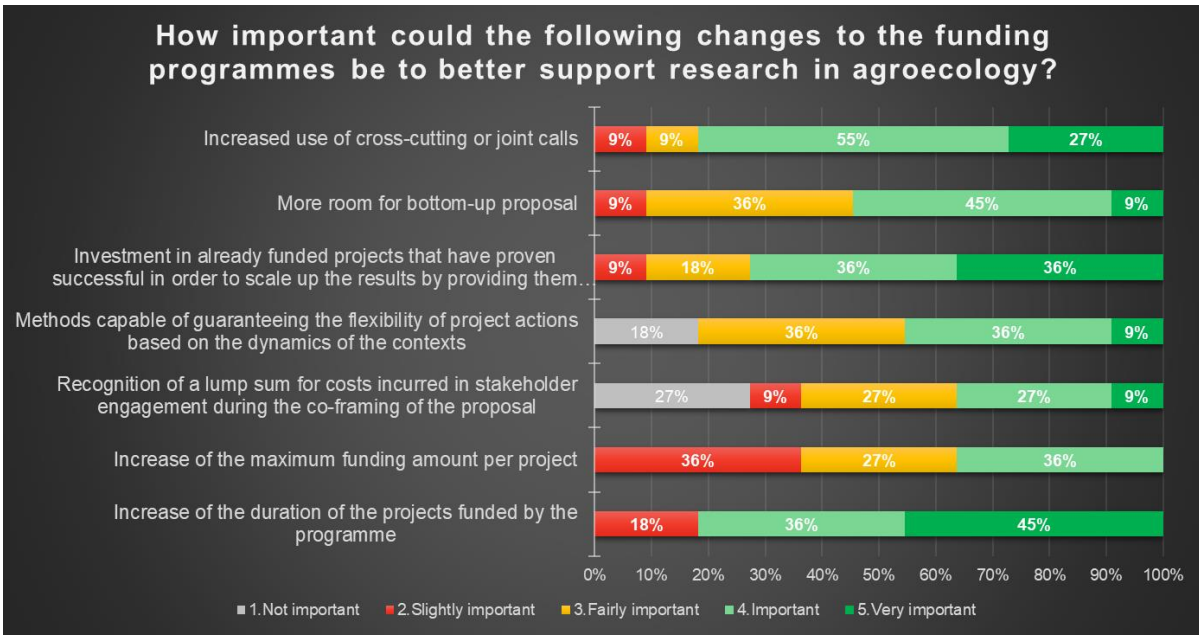

Figure 24. Percentages of importance of changes (according to 5-point Likert scale) for the respondents to implement in programmes funding research in agroecology

According to what reported by researchers involved in AE, "*Increase of the duration of the projects funded by the programme*" (μ=4.1, CV= 28%) was considered the most important change to implement in funding programmes. It was followed by "*Investment in already funded projects that have proven successful in order to scale up the results by providing them with extra funding*" (μ=4.0, CV= 25%) and "*Increased use of cross-cutting or joint calls*" (μ=4.0, CV= 25%), options which instead received less importance by the researchers. On the contrary, "*Recognition of a lump sum for costs incurred in stakeholder engagement and consultation during the co-framing of the proposal*" (μ=2.5, CV= 71% given especially to the low values provided by EU programme leaders), "*Increase of the maximum funding amount per project*" (μ=3.0, CV= 54%), and "*Introduction /presence of methods capable of guaranteeing the flexibility of project actions based on the dynamics of the contexts*" (μ=3.0, CV= 30%) were considered the least important needed changes.

Unlike the other surveys, few comments and lessons learned were left in the open questions by the respondents on this survey. They are:

"*The call was not mentioning directly agroecology, but it was including many agroecological principles. The main lesson learned is that researchers working in agroecology need to look also for calls not explicitely mentioning agroecology and use them to go on with their own research stream*"

"*Transmultidisciplinary approach and knowledge transfer to the end-users are fundamental*"

"*Alignment and finding compromises regarding national regulatory frameworks and funding programmes is the basis for any transnational activity. It is important to have resources in order to prepare and manage this alignment properly, especially if the thematic (like agroecology) is not synonymously used and clear*"

4. Conclusions and recommendations

"*The difficulty is now that the concept of agroecology is not understood in the same way by all actors. Twenty years ago, we all agree on its foundations. Now, the green washing in all areas makes difficult to be recognised as main actors of agrocecological transition. The actors of the dominant system have changed the challenge. It is no more to organise ourselves to improve our projects but to maintain them visible. We need to fight in order to keep the authentic values behind our concepts, and to make them recognised*." This comment left by a respondent in one of our surveys clearly highlights the presence of two contrasting research approaches in agroecology, one more compliant with the dominant so called productivist model and the other more inclined to its transformation. Today more than ever, given that the boundaries between these two approaches are becoming confused, it is necessary to make the original transformative role of agroecology more visible and strongly highlighted.

Indeed, with the idea that is gaining ground that agroecology cannot feed the world, "green" concepts of the productivist model such as sustainable intensification, eco-efficiency, GMOs for integrated pest management are currently in use also within AE researchers (as reported by our surveys especially at the national level) to justify any form of intensification. These scientific solutions are still designed by reasoning at the scale of single crop or field without reflecting to the complexity of the whole agri-food system to which agroecology instead aspires. And these concepts related to the dominant regime come back *en vogue* especially in times of a crisis such as the one we are facing with the Ukraine conflict.

Even if in the past agroecology was not explicitly mentioned in any funding programmes at all levels, now it finally appears in a clear and evident way within both the last calls of the European programmes in the new Horizon Europe framework (2021-2027) and at the Transnational level with the new partnership "*Accelerating farming systems transition: agroecology living labs and research infrastructures*". Therefore, both European and Transnational funding research programmes must now foster and promote the transformative paradigm of agroecology in order to drive and harmonize the national funding research programmes for agroecology of the various European countries towards this vision, too. In doing this, **topics addressing at least the level 3 of Gliessman's framework should be promoted**. Specifically, those issues that have currently been slightly addressed by research in agroecology (according to our surveys: resilience in level 3, social and governance aspects of level 4 and 5) should be given more attention. At the same time, future research programmes should be designed to not emphasise the relevance of research topics addressing level 1 and 2 of the Gliessman's framework but starting from level 3 as baseline.

To address the social challenges posed by agroecology (especially those related to level 4 and 5), **research should involve a greater number of actors** from the entire agri-food system, in particular those who are less represented such as upstream and downstream value chain actors as highlighted by our surveys. Indeed, various actors may have differing and even conflicting views on what problems are most relevant and what transformations are required. Therefore, in order to include and reflect on complex interrelationships between sociocultural, economic, and biophysical dimensions, research in agroecology must consider the entire agri-food system together with its actors and not only the field and/or farming scales.

Actor engagement in the research process is also suggested as a key element to allow a more rapid diffusion of the solutions identified in the research thus increasing its impacts and guaranteeing a scaling up and out of agroecology. Transdisciplinary which is a collaborative mode of knowledge co-production oriented towards specific societal challenges and that integrates knowledge and perspectives from different scientific disciplines and other societal actors, is strongly recommended in the interaction with non-academic actors to further increase research impact. Funding research programmes in agroecology must support and require transdisciplinary research more effectively. **Any funding programme aiming to strengthen transdisciplinary research must explicitly demand transdisciplinary designs and processes.** As suggested by Schneider et al. (2019) the implementation of these designs and processes must be clearly described in the annual reporting by fund receivers and programmes must understand if the transdisciplinary efforts implemented in the research are sufficient or not, and, in case, ask for improvements. Moreover, programmes should foster research aiming to re-integrate co-produced knowledge both into scientific (*systems knowledge*) and societal practice (*transformation knowledge*) with outcomes that are likely to have a transformative impact on society. At the same time, programmes must be aware that transdisciplinary efforts imply to allow flexibility if ongoing interactions with actors require some adaptations of the original research proposal and design. At the moment, this flexibility seems to be strongly requested by researchers involved in AE but it is not guaranteed and wished by programme managers**. Institutional and procedural innovation to introduce flexibility is necessary.** Also, where appropriate, the alignment of the national project funding and reporting procedures to the EU ones may represent the first step to mitigate the issue. On the contrary, both sides (researchers and programme leaders) agree on **the need to increase the duration of projects dealing with agroecology thus that contributions to societal transformation often require more time to unfold**. Moreover, our results demonstrated that, in addition to project duration, also **the budget dimension is related to project complexity in terms of number and type of actors involved, appropriate problem framing and in knowledge production and fruition**. This evidence should be taken into consideration by

the future transnational research planning, that should be designed in order to promote the funding of larger project than those on average transnationally financed in the past, thus avoiding small projects which might result to simplified, as well as very large not-efficiently manageable ones.

Living labs are also considered very useful approach to strengthen transdisciplinary and innovation, and the new partnership on agroecology is moving in the right direction having chosen LLs as a strong point to accelerate innovation and strengthen the sustainability of farming systems. However, as highlighted by the results of our surveys, **further efforts must be made to identify those elements that a LL must have in order to truly guarantee the implementation of transdisciplinary approaches thus allowing a more rapid diffusion of agroecological innovation**.

Lastly, the overall picture of the agroecology research connections in Europe, evidenced by the network analysis we performed, showed the way in which the scientific communities dealing with agroecology interact and collaborate in EU, evidencing strengths and quality features to be further exploited. Also, the analysis revealed weakness, unnecessary fragmentation and, in some cases, research community isolation due to barriers of different nature that negatively impacted on agroecology research implementation; barriers to be removed designing effective research programmes.

Box 1. 10 main recommendations to foster agroecology research in Europe

1. to plan and to implement research that considers the entire agri-food system together with its actors and not only the field and/or farming scales
2. to design research programmes considering the barriers that generates unnecessary fragmentation and research community isolation which negatively impact on EU agroecology research implementation
3. to promote research programmes addressing - at least - the level 3 of Gliessman's framework and going beyond, including social and governance aspects of level 4 and 5
4. to get away from research programmes addressing dominantly the level 1 and 2 of the Gliessman's framework
5. to design funding research programmes aiming to strengthen transdisciplinary research, explicitly demanding for transdisciplinary designs and transdisciplinary processes implementation
6. to effectively identify the Agroecology Living Labs elements to truly guarantee the implementation of transdisciplinary approaches
7. to encourage the involvement of a greater number of actors from the entire agri-food system, in particular those who are so far less represented, such as upstream and downstream value chain actors, and the non-economic actors of the food system (i.e. citizens)
8. to introduce institutional and procedural innovation to guarantee higher flexibility in research projects implementation
9. to increase the duration of projects dealing with agroecology
10. to discourage too small projects which might result to simplified, as well as very large not-efficiently manageable ones

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