D7.2 FIRST SET OF RECOMMENDATIONS FOR FUTURE RESEARCH AGENDAS

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First set of recommendations for future research agendas

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Acronyms

AMR	Anti-microbial Resistance
EC	European Commission
EU	European Union
JPIAMR	Joint Programming Initiative on Antimicrobial Resistance
LTVRA	Long Term Vision for Rural Areas
MAP	Multi-Actor Platform
SCAR-AKIS	Standing Committee on Agricultural Research - Agricultural Knowledge and Innovation Systems
SHERPA	Sustainable Hub to Engage into Rural Policies with Actors
WHO	World Health Organisation

Executive Summary

The process used in the SHERPA project has led to positions taken on specific topics, principally visions for rural areas, and on protecting and enhancing biodiversity through landscape features. The methodology adopted led to a set of recommendations for future research aligned to a set of policy priorities.

The SHERPA process identified gaps in current knowledge and priorities for future research. The tools developed, such as the webcrawler, enabled the identification of information on research projects funded through European Union (EU) research programmes (principally Framework 7 and Horizon 2020). They identified projects that have remits or outputs that in the thematic areas of the seven enablers required for achieving the long term visions for rural areas, carried out by the SHERPA Multi-Actor Platforms.

The number and value of those projects for each thematic area are: Rural Economies (139 projects, 417.57m Euros), Climate, Environment and Sustainability (60 projects, 238.35m Euros), Knowledge and data (89 projects, 226.25m Euros), Smart Ruralities and Digitalisation (52 projects, 176.35m Euros), Governance and Participation (33 projects, 96.51m Euros), and Basic Services and Infrastructure (12 projects, 32.46m Euros).

Outputs from the research projects within each thematic area were reviewed to identify gaps in knowledge and recommendations for future agendas of research. These findings were synthesised into a set of recommendations for future research in the topic of rural areas. A set of eight areas of research agendas were identified:

- Planning coherent, equitable, multi-functional land uses
- Creating conditions and facilitating the generation of wealth by rural communities
- Well-being economies of rural areas
- Relationships between changes in consumer behaviours towards foods and diets and characteristics of rural areas
- Supporting the sustainability of digitalisation
- Systems approaches to Integrated Pest Management with Land Management
- One Health approach to developing strategies for antimicrobial stewardship
- Observation, monitoring and reporting

The gaps in evidence or knowledge provide a synthesis of supply and demand led perspectives. They reflect where there are weaknesses in the current evidence base, and topics within which there is likely to be a need for future knowledge, such as the Rural Action Plan of the European Union Long Term Vision for Rural Areas. They also reflect the thematic and geographic coverage of the SHERPA project in Phase 1, and the availability of contemporary recommendations from relevant EU funded projects. Findings from more recently funded projects can be expected to fill some of the gaps in evidence and knowledge, and thus move forward research agendas.

The areas of research are in line with the strategic research needs identified by the EU in the orientations of the Horizon Europe programme (European Commission, 2021a), and the candidate topics of the European Partnerships (DG Research and Innovation, 2020). Several also align with prospective recommendations for research of Horizon Europe Missions (European Commission, 2021a).

1. Introduction

The aim of this Deliverable, D7.2, is to present the first set of recommendations for future research agenda based on the work done by the SHERPA partners during the first 24 months of the project. The recommendation focuses on priorities for policy affecting rural areas that will align with strategies of the EU. It uses the evidence and recommendations produced in Phase 1 of the Discussion and Position Papers of the SHERPA Multi-Actor Platforms (MAPs), the SHERPA Position Papers, supported by evidence from high level recommendations harvested from other EU funded projects.

As Phase 1 of the MAPs focused on the visions of the future of participating rural areas by 2040, to contribute to the EU Communication on a Long-term Vision for Rural Areas (LTVRA), published in June 2021, the first set of recommendations for agendas of research are based on a gap analysis between the needs as identified by SHERPA and its MAPs and the Horizon Europe call for proposals, and current FP7 and Horizon 2020 projects. This is augmented by research priorities identified in the SHERPA pilot study with 3 MAPs on protecting and enhancing biodiversity through landscape features.

The first section of this report presents an overview of the needs identified by SHERPA to achieve the visions for rural areas by 2040, and the contribution of landscape features to biodiversity. This is followed by a summary of the results of the mapping of the identified needs of SHERPA and the Horizon 2020 and Horizon Europe calls for proposals, and previous and current FP7 and Horizon 2020 projects.

Topics of future agendas of research which emerge from the SHERPA papers are summarised, and their relevance to policy priorities identified. The Topics identified are not exhaustive, reflecting the thematic and geographic coverage of the SHERPA project in Phase 1, and the availability of contemporary recommendations from relevant EU funded projects. Findings yet to emerge from those projects, and those of projects funded under calls (e.g. H2020 Green Deal call; European Commission, 2019) yet to start, can be expected to fill some of the gaps in evidence and knowledge, and thus move forward research agendas.

The research agendas are then discussed in the contexts of policy areas of the strategic orientations of Horizon Europe (European Commission, 2021a), the prospective European partnerships (DG Research and Innovation, 2020), the emerging priorities of the Horizon Europe Missions (European Commission, 2021a) and the Long Term Vision for Rural Areas (European Commission, 2021b).

2. Methodology

The approach to identifying gaps in knowledge and priorities for research within the overall topic of rural areas comprised the following steps:

- To identify thematic areas relevant to research relating to rural areas, guided by the Position Paper on the visions for rural areas (SHERPA Position Paper, LTVRA; Chartier *et al.*, 2021);

- To search, identify and summarise research efforts in these thematic areas, as investments in EU research programmes;

- To review the Discussion and Position Papers produced by SHERPA in the first 24 months and identify gaps and recommendations for future research;

- To review identified gaps and recommendations for future research within projects selected;

- To synthesise findings into a set of recommendations for future agendas of research.

Lessons learnt on the steps of the methodology are summarised in each section, providing feedback into the second iteration of the process within the SHERPA project.

3. Contexts for Research Identified by SHERPA

Through its process of multi-level MAPs and dialogue with actors in science, policy and society, SHERPA has identified contexts for new knowledge, data, and research in support of policies for rural areas. The MAPs comprise approximately 250 actors across science (45% to 50%), policy (20% to 25%) and society (25% to 30%) (Potters *et al.*, 2020), providing insight of the needs to all three sectors of actors.

The process of developing a first set of research agendas draws on the two rounds of the SHERPA process which were run during the first year of the project (2019/20). One round was a pilot of the process by three MAPS which focused on the topic of protecting and enhancing biodiversity through landscape features (Mottershead *et al.*, 2021). The second round was across all the MAPs, and explored the vision and desired futures for 2040 for their rural areas, from which contributions were developed to submit to the EU long-term vision for rural areas (Chartier *et al.*, 2021).

In each case, the approach was the development of a Discussion Paper to inform engagement with the MAPs at EU and local levels, and equivalent discussion papers focusing on their local regions. From these discussion papers, Position Papers were produced by the individual MAPs, and an overall SHERPA Position Paper (Chartier *et al.*, 2021). In turn, the findings from Position and Discussion Papers, and across levels have been used as a basis for synthesising recommendations or interpreting conclusions in relation to gaps in scientific knowledge, and areas within which those gaps may be brigaded into research agendas.

3.1. SHERPA Topic: Protecting and Enhancing Biodiversity through Landscape Features

In its study of protecting and enhancing biodiversity through landscape features, the SHERPA Position Paper (Chartier *et al.*, 2021) concluded that: "When prioritising further research, it is important to take a holistic approach. For example, they noted that it is equally important to understand the health benefits of biodiversity features *and* their importance to farm profitability" (Mottershead *et al.*, 2021; Italy Emilia Romagna MAP, Targetti and Viaggi, 2020).

Key gaps in knowledge identified were:

- Interdependencies of keystone species and habitat types;
- Relationships between the extent and interactions between landscape features, biodiversity and ecosystem services (especially provisioning);
- Production models that support landscape features over the long term;
- Social and technical innovation for the monitoring and evaluation of landscape features.

3.2. SHERPA Topic: Long Term Visions for Rural Areas

In the development of visions for rural areas, the SHERPA MAPs used a Delphi process comprising six steps: i) desk research and context analysis, ii) interviews, iii) interview analysis (which resulted in a MAP Discussion Paper), iv) a survey of members of the MAP, v) analysis of the survey data, and vi) the validation of results. This process resulted in 17 MAP Discussion Papers and 18 MAP Position Papers, which contained the challenges and opportunities identified by the MAPs for the next 20 years in rural areas, visions for rural areas by 2040, and enablers necessary to achieve the desired futures by 2040 for the rural areas covered by the MAPs.

This information was synthesised and used as inputs to meetings of the EU-level MAP. The EU-level MAP provided feedback on this synthesis and added an EU-level perspective. This information (i.e. the synthesis

of the MAP Position Papers and the information provided by the EU-level MAP) was analysed and drawn together into the SHERPA Position Paper on the Long-Term Vision for Rural Areas (the high level contribution of SHERPA to the EU long-term vision for rural areas; Chartier et al., 2021).

The SHERPA Position Paper (Chartier et al., 2021) identified seven key thematic areas highlighted by the MAPs as most important in their visions for the future. For each thematic area, the SHERPA Position Paper indicated the vision of the MAPs for the future of rural areas, and the enablers for achieving this vision as identified by the MAPs. These thematic areas raise questions about requirements for new knowledge and thus research requirements. A summary of these thematic areas follows.

i) Basic services and infrastructure

The visions for the future of rural areas have enabling conditions for their social and economic attractiveness that depend on accessing basic services (Italy Tuscany MAP; Arcuri and Galli, 2021). Achieving those visions requires more and better opportunities for education and training in rural areas, improved infrastructure, better access to services, and the availability of sustainable and innovative models of mobility (e.g. Finland MAP; Kull et al., 2021). To achieve this it is valuable to recognise the linkages between services that are self-reinforcing. For example, it is necessary to improve the models of provision of services (e.g. within rural areas and not indirectly by the provision of transport to city-based service hubs), and the means by which providers of services (e.g. individuals with specialist skills, and employee flexibility and the adaptation of skills; Féret et al., 2020), all members of the families of those providers (e.g. careers for partners, education for all ages of children), and how changes in lifestyles through life stages can be satisfied within rural areas (e.g. life-long learning; Lithuania MAP; Gedminaite-Raudone and Vilke, 2021; UK MAPs, Miller et al., 2021). Research is required on gaps in services mapped onto current and future requirements as drivers and supports of the development of rural areas.

ii) Climate, environment, and sustainability

The visions of the future focused on environmental conservation, being to the fore in the tackling of climate change, and improving biodiversity (e.g. Chartier et al., 2021). Agriculture is anticipated to be thriving, modern, and based on sustainable practices, including increases in organic and agro-ecological farming practices. The circular economy is expected to grow, taking opportunities of new technologies, and changes in public attitudes towards resource use and reuse (see also Thematic Area 6). To achieve this vision, there is a need for evidence that can: a) support policies and practices to be designed that tackle climate change and protect and enhance environmental sustainability; b) improve the planning of land use; c) territorially tailored approaches to help transitions to sustainable and equitable production systems (e.g. compensate for loss of yields, respect communities of interest and place (Italy Emilia Romagna MAP, Targetti and Pellegrini, 2021; UK MAPs, Miller et al., 2021; Smith et al., 2021).

iii) Smart rurality and digitalisation

It is envisaged that digitalisation and digital technologies are highly integrated within the rural economy, with place-based development through smart specialisations. Digitalisation provides as one means of narrowing the gap between rural and urban areas (e.g. in health care and mental wellbeing, education, for individuals and communities; e.g. Spain Aragon MAP, Folkeson and Bardají, 2021; UK MAPs, Miller et al., 2021). However, there are needs to understand barriers to uptake, and lessons to learn from the experiences of the use of digital tools pressed into use as a consequence of restrictions linked to COVID-19, and evaluating impacts of improved connectivity through reducing digital exclusion.

iv) Governance and participation

The future vision of rural areas of SHERPA MAPs identified the need for better urban-rural connectivity (e.g. Lithuania MAP; Gedminaite-Raudone and Vilke, 2021; ROBUST), a revalorisation of the role of rural areas, bottom-up approaches and inclusivity in governance and improved local co-operation in rural communities. Frameworks are needed that facilitate the development of social and human capital in rural communities,

and enable local actors to participate actively in the governance of rural areas (German MAP; Schwarz and Stauß, 2021). This vision can be enabled by empowering local actors and communities, enhancing multi-level and territorial governance, and improving funding for specific activities in rural areas. There is also a need to introduce, or share knowledge and innovation into multiple levels of governance as part of solutions to avoiding, negotiating and resolving conflicts (Italy Tuscany MAP; Arcuri and Galli, 2021; SHERPA Discussion Paper, Féret *et al.*, 2020). **Research issues arise** in relation to the tailoring of models of governance to different cultural and geographic contexts and political systems, and relationships and dependencies between territories.

v) Knowledge, data, and images

There is an anticipation and expectation of an increase in the availability and use of scientific data and knowledge in relation to rural areas. This will be consistent with the progress on projects adhering with principles of Open Science, and the provision of open data. These materials can be used to broaden their accessibility and use for informing discussion and decisions relating to rural areas, and for the creation of positive images and narratives about rural areas, now and of their futures (e.g. Netherlands MAP; Groot and Vermue, 2021). There is recognition of the importance and need for local knowledge and data as prerequisites for developing and implementing place-based policies, and the availability of detailed spatial statistics for the governance of rural areas (Finland MAP; Kull *et al.*, 2021). There is also recognition of increasing disconnection between land-based industries and local populations which leads to gaps in understanding of systems of management of land, and sea, and the consequent issues faced (UK MAPs, Miller *et al.*, 2021).

Research and knowledge exchange infrastructures form part of the theme, as creators and sources of data, methods and knowledge, and collaborators in providing learning opportunities and mechanisms. **Research issues arise** in relation to barriers to uptake and exploitation (e.g. human capital), accuracy and completeness of data, and how images of rural areas are created equitably and interpreted by those who live and work in urban areas (e.g. German MAP; Schwarz and Stauß, 2021).

vi) Rural economies

There is a desire for a more diversified rural economy, that is vibrant, dynamic and resilient, with a countryside attractive to all age groups and within which to live, work and spend leisure time (e.g. Slovenia MAP; Erjavec and Rac, 2021). Natural resources are used innovatively (e.g. natural capital), and opportunities taken to develop bio-economies that complement traditional primary industries of agriculture, forestry and fishing (e.g. Denmark MAP, Refsgaard and Ormstrup Vestergård, 2021), and enable targets of net zero emissions to be achieved (e.g. renewable energy, Czechia MAP, Krist *et al.*, 2021). Such opportunities should reflect needs for transitions to economies based on clean energy, recognizing implications for population centres the locations of which are explained by that of natural resources (e.g. coal, oil, wood, water), and the consequential emergence of industrial activities (e.g. ENTRANCES).

New interests in tourism are stimulated, linked to enriching the offering of rural areas (e.g. gastronomic and cultural tourism; e.g. Greece MAP; Nicoleta and Evangelos, 2021). **Research issues arising** include understanding the uses of places within rural areas (e.g. Finland MAP; Kull *et al.*, 2021), and key capacities that require to be developed to enable visions of rural economies to be realised, and the timescales required for them to evolve, and the relationships between rural social entrepreneurs and their institutional environment (RURINNO).

The interactions between rural and urban or metropolitan areas have implications for the uses of land (e.g. commuter housing, recreation), infrastructure (e.g. transport, energy) and contributes to the economic activities of rural areas (e.g. supply chains, services, employment of non-commuters) (MAPS-LED).

Gaps in knowledge include understanding the long term collaboration practices between stakeholders (LivRUR), and provision of intermediate space to link institutional innovation with the social economy (RURINNO).

vii) Social capital

In the future envisaged there is a stable and sustainable demographic structure, integration of "new rural residents" migrating from urban centres and other territories, and from outwith the EU, improved local co-operation, local food production (e.g. Romania MAP; Brumă and Tudor, 2021) and consumption supported by short supply chains (e.g. Italy Emilia Romagna MAP, Targetti and Pellegrini, 2021), appreciation, trust and cooperation between the different actors in socially and culturally viable rural communities (e.g. German MAP; Schwarz and Stauß, 2021), and a high quality of life and well-being for rural residents. There is also a need to understand how migration between urban and rural areas helps improves social connectivity (Lithuania MAP; Gedminaite-Raudone and Vilke, 2021). To enable this future, there is a need to develop policies and tools for enhancing the attractiveness, quality of life and well-being in rural area, and to place young people at the centre of the expected outcomes of policy. **Research issues arising include**: a) understanding social networks through and around which social capital is established and distributed, and bridging social capital (e.g. the qualities of nature, and the purposes of links between communities); b) the triggers for social innovation; c) the evolution and trajectories of social capital over the long term.

The process for creating the visions for rural areas, and thus the thematic areas they comprise, was through the first 9 months of the COVID-19 pandemic. The experiences and lessons gained from the changes in infrastructure (e.g. digital tools), availability of goods (e.g. interruptions to long supply chains), and the nature, effectiveness and uptake of innovations (e.g. social, technological) informed the content of the discourse of the MAPs. Some of the issues identified reinforced themes which had been emerging, such as the triggers of social innovation, sensitivity of rural areas to long supply chains, the roles of digital solutions across a broad range of services, importance of the natural environment to human health and well-being, and of issues which were previously unknown, or about which additional knowledge gaps emerged (e.g. consequences of migration flows through stages of an international crisis).

4. Gap analysis

Gaps were identified between the needs identified in SHERPA, and the projects supported in FP7 and Horizon 2020 projects.

The seven long-term needs of rural areas identified through the SHERPA MAPs (Section 3) were mapped onto the ongoing and upcoming Horizon Europe (2021/22) calls for proposals, to identify gaps in the calls compared to needs, using information in the European Commission's Funding and Tender opportunities for Horizon 2020 website about calls which are currently open or forthcoming. In addition to these needs, the SHERPA MAPs identified the need for the use of foresight methodologies to scan for emerging changes and analyse trends in rural area, with a view to revealing prospective opportunities for the future. The search focused on calls relating to rural research, identifying 46 calls in Horizon Europe, listed in Annex 1.

The first phase of the analysis identified the number of calls covering the thematic needs which emerged in the SHERPA Position Paper on the Long-Term Vision for rural areas (Figure 1; Chartier *et al.*, 2021). As shown, "Smart rurality and Digitalisation" (14), "Social Capital" (10), "Basic services and infrastructure" (4), and "Foresights" (4) are addressed by fewer calls for proposals. More calls covered the themes of "Climate, environment and sustainability" (36), followed by "Knowledge, data and images" (28) and "Rural economies" (22).

Figure 1. Number of calls for proposals in Horizon Europe (2021/22) by thematic area identified in SHERPA MAPs (Source: derived from EU funding and tenders portal mapped onto thematic areas)
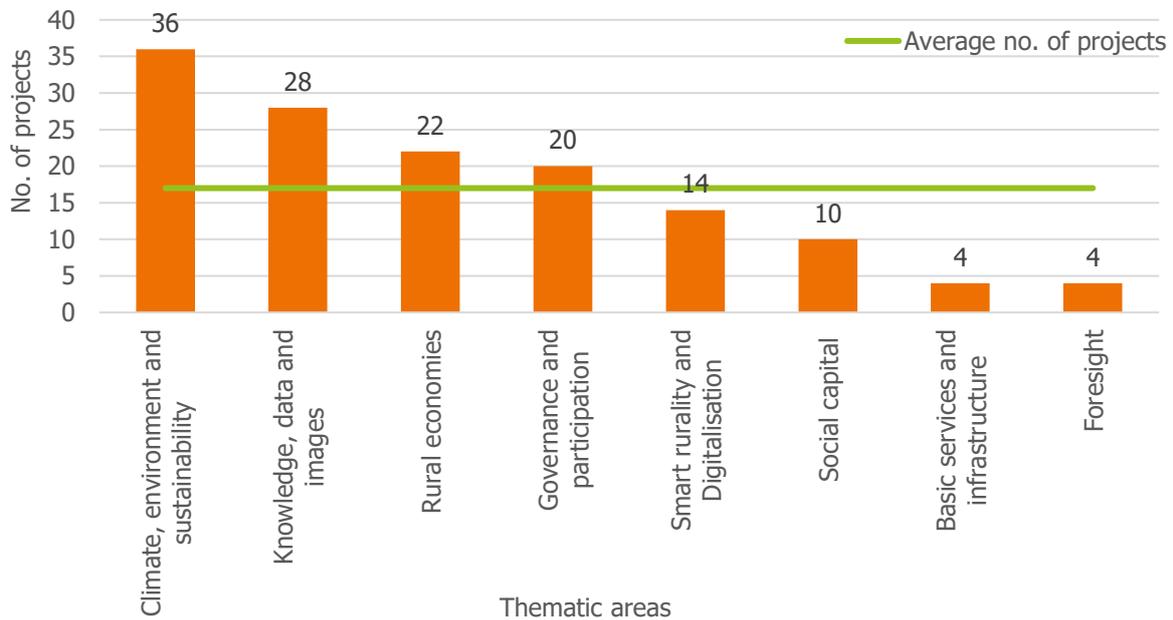
The second step of the evaluation included the budget allocated to the relevant calls. This criterion enabled identification of the level of funding which would contribute to addressing each of the themes identified by the SHERPA MAPs (Figure 2).

Interpretation of this summary of resources recognises that the calls for proposals considered in the assessment are considerably broader than the thematic areas identified. Therefore, the financial resources are not available solely to address the topics identified.

A total of 198 calls for proposals are included in Horizon Europe (2021/22) which are likely to deliver new knowledge and outputs relevant to thematic areas that support the visions for rural areas generated by the SHERPA MAPs. Of those, four sub-thematic areas appear well supported (Knowledge, Sustainability, Rural Economies, and Environment), and three have significantly lower support (basic services, smart rurality, and infrastructure).

There is a significant budget allocated to calls for proposals which focus on the thematic areas identified in SHERPA MAPs of "Climate, environment and sustainability" and "Knowledge, data and images"; over 200 million Euros for either thematic area. By comparison, there are fewer resources allocated to thematic areas of "Social capital" (135 million Euros), and "Basic services and infrastructure" (32 million Euros). This finding is consistent with the results shown in Figure 1, confirming that these latter three thematic areas have a lower level of investment in Horizon Europe calls published to date than the other five.

Figure 2. Total budget allocated to projects in Horizon Europe (2021/22) by thematic area identified in SHERPA MAPs (Source: derived from EU funding and tenders portal mapped onto thematic areas)
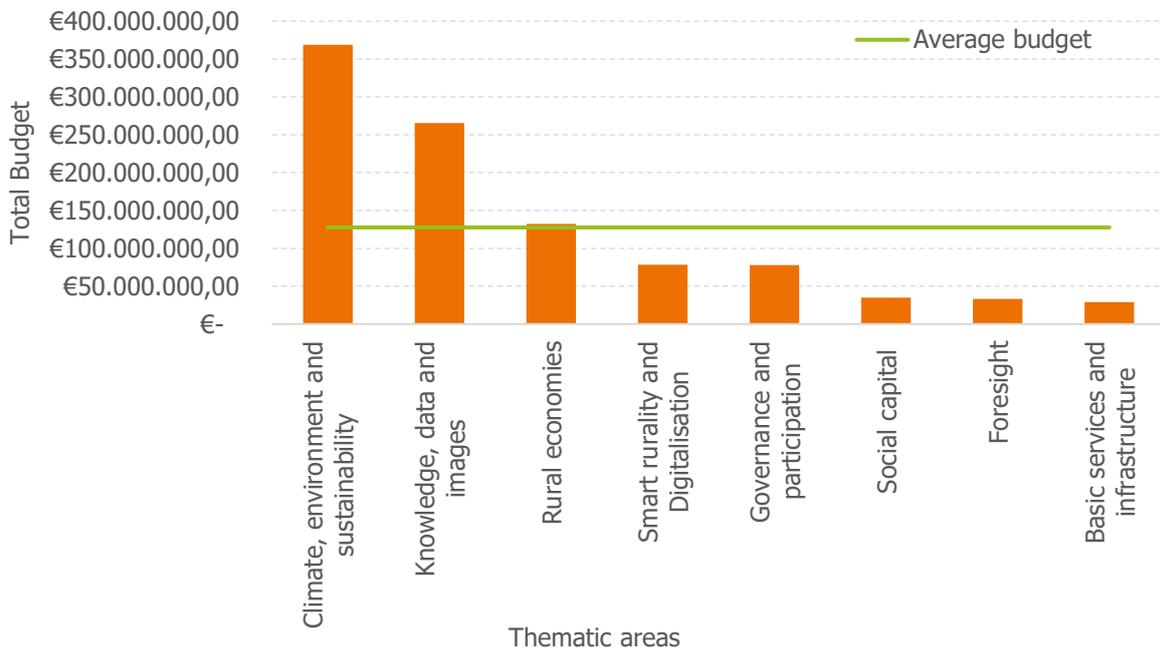
Figure 3 shows the number of projects addressing each thematic area. The number of projects reported in Figure 3 suggests greater investment is planned in the sub-thematic areas of *Sustainability (29 projects)*, *Environment (28 projects)*, *Knowledge* (26 projects) and *Rural Economies (22 projects)*, and lower investment in *Basic Services (3 projects)*, *Smart Rurality (3 projects)*, and *Infrastructure (2 projects)*. Very few projects (4 out of 198) include reference to *Foresighting* or future scenarios.

Figure 3. The number of projects planned in Horizon Europe (2021/22) by sub-thematic area identified in SHERPA MAPs (Source: derived from EU funding and tenders portal mapped onto sub-thematic areas)
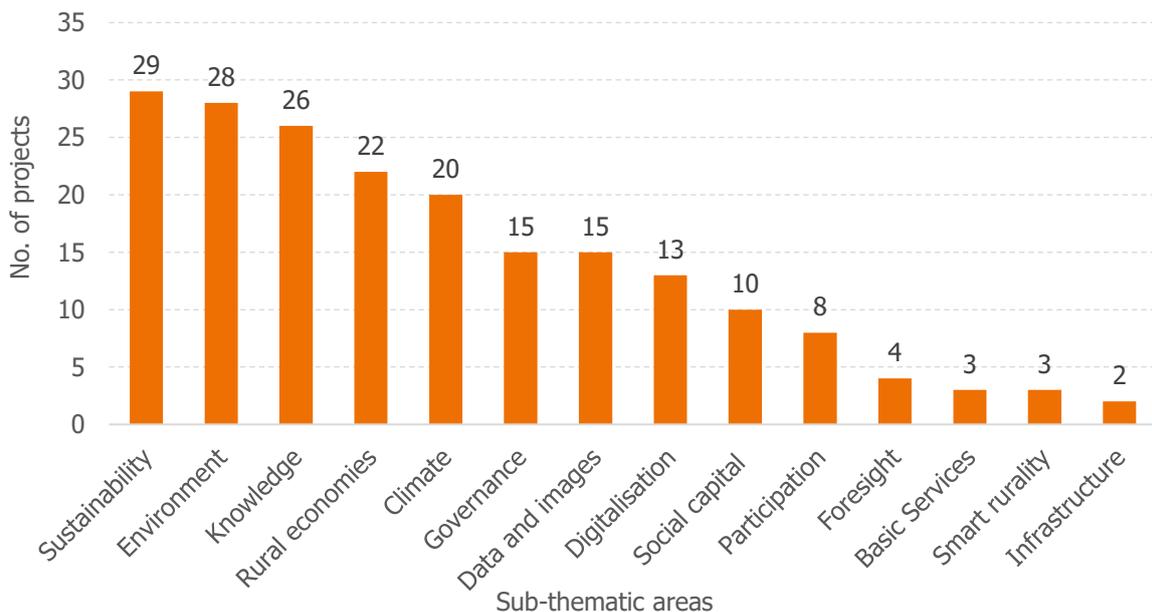
A summary of the number of projects and values of the projects funded under FP7 and H2020 programmes on the thematic areas of needs for achieving the long term visions for rural areas is provided in Annex 2. The thematic area in which there are the most projects, and the greatest total value, is that where there are remits or expected impacts on *Rural Economies* (139 projects, 417.57m Euros). That is followed by the thematic areas *Climate*, Environment and *Sustainability* (60 projects, 238.35m Euros), *Knowledge and data* (89 projects, 226.25m Euros), *Smart Ruralities and Digitalisation* (52 projects, 176.35m Euros), *Governance and Participation* (33 projects, 96.51m Euros). The thematic area with the fewest projects, with the lowest total value is that of *Basic Services and Infrastructure* (12 projects, 32.46m Euros). Note that several projects will be included in more than one category, reflecting their remits and activities (e.g. new types of data and its exploitation of digitalisation tools).

5. Recommendations for Research

The rapid appraisal of projects, including searches for recommendations or conclusions for future research agendas aligned to policy priorities, enabled a synthesis of topic areas within which research priorities could be identified, aligned to thematic areas or policy priorities. The topics and content were reviewed by domain experts within the SHERPA consortium.

In the context of the remit of SHERPA, the research needs and consequent agendas should contribute to the body of knowledge of their topic or theme through a rural lens. That is, the intended outcomes of research, and the operation of project activities, should provide evidence that informs the transition towards the overall direction set in the LTVRA (European Commission, 2021b) of stronger, connected, resilient and prosperous rural areas by 2040.

There is also recognition amongst the MAPs of the benefits of transdisciplinary research, thus collaborative working amongst science, policy and society (or practice). The benefits sought are the targeting of research to create the impacts intended, and of enabling co-learning, and building human and social capital through the process of research. This is also consistent with the opportunity of using the processes and structures of the research as drivers of transitions in rural areas, and should be designed to contribute to those transitions being just and equitable.

The principal recommendations are summarised below.

Topic: Planning coherent, equitable, multi-functional land uses

Issue – Land is a unique asset that has multiple functions that support life on earth. Land use is the social and economic purpose to which we put the Earth's surface (Mather, 1986). Some of the functions of land uses are readily recognised and understood (e.g. production of raw materials), others may be characteristics that have no visual, audible or olfactory cues (e.g. emission or sequestration of CO_2, cultural associations). To tackle global challenges such as climate change and reversing the loss of biodiversity requires harnessing the multiple functions that land can contribute, some through natural processes and other through technical and social innovations (pluri-activity, France MAP, Rolland *et al.*, 2021; multi-functional, Denmark MAP, Refsgaard and Ormstrup Vestergård, 2021). Innovations in land use may lead to the introduction or transfer of uses which are common in one area to another in which there is little or no recent history (e.g. solar renewable energy), or be the first in any area (e.g. first trials of vertical or indoor farming) (Spain Galicia MAP, Guimarey *et al.*, 2021). They may also be catalysts to other configurations or connections between land uses (Italy Tuscany MAP; Arcuri and Galli, 2021). Such transformations or evolutions in uses need to respect the rights and values of the communities of place, and of interest, those who live, work, visit, benefit from or pay for the management and changes in land use, directly or indirectly, and from perspectives across gender, age and ethnicity. As such, these make the planning of land use place-based.

Direct and indirect pressures on land cover, land use and landscape have different impacts, with changes that may operate over short or long timescales. The current uses of land are manifestations of evolutions of

previous uses (e.g. agriculture, "natural" vegetation), and stages in the preparation for future uses (e.g. renewable energy). The configurations or land cover, use and management contribute to its natural capital. Investing in natural capital can contribute to tackling priorities of mitigating or adapting to climate change, reducing the loss of biodiversity, and rural development (e.g. UK MAPs, Miller *et al.*, 2021). Such investments can be in components of land systems that offer new pathways of rural development. For example, investing in the restoration of peatlands, has associated requirements of infrastructure for monitoring and modifying actions, with consequent requirements for new skills and expertise (e.g. in animation), provision of raw materials and equipment, and creating opportunities for developing local training facilities and inputs to programmes of learning and education and help young people broaden their horizons (UNISECO; France MAP; Rolland *et al.*, 2021; Greece MAP; Nicoleta and Evangelos, 2021).

Needs – There is a need for greater understanding of the functions of land, as part of a contribution towards better informed visions, debate and decisions about its future uses, and pathways towards those being realised. There are also needs for means of: i) incentivising the planning of land uses that contribute to achieving multiple economic, environmental and social aims; ii) understanding the changes through time of the trade-offs between impacts and benefits of uses of land as they evolve (e.g. on citizen health, revenue streams, habitat networks, landscapes; Slovenia MAP, Erjavec and Rac, 2020; UK MAPs, Miller *et al.*, 2021); iii) enabling communities of place to realise the benefits of uses of land to enable ongoing investment (e.g. through innovation); and, iv) research and development of new uses of natural resources, such as nature-based solutions (e.g. Portugal MAP; Santos and Mendes, 2021; Italy Emilia Romagna MAP, Targetti and Viaggi, 2020), and innovative institutional arrangements for handling contested issues (UK MAPs, Miller *et al.*, 2021).

More specific needs, relating to aspirations set out in the EU Green Deal (e.g. European Commission, 2019), Farm to Fork Strategy (European Commission, 2020a), and Biodiversity Strategy 2030 (e.g. European Commission, 2020b) (e.g. RURITAGE, MOVING, HNVLINK), include filling gaps in knowledge regarding interactions of landscape features in agricultural systems in High Nature Value and naturally constrained areas (Mottershead *et al.*, 2021; SHERPA); v) modelling changes in, and prospective future land uses, that deliver on global challenges of mitigating and adapting to climate change, reversing the loss of biodiversity and alleviating poverty.

Example research questions – How can better management of landscape features improve the economic performance of rural businesses, at site and territorial levels? How can the rights, knowledge and responsibilities of communities of place and communities of interest be balanced to create conditions for pathways towards equitable changes in land use? How can place-based approaches take account of both communities of place and of interest?

Informed by H2020 HNVLINK, INSPIRATION, LandMarc, LANDSENSE, MAGIC, MOVING, RURINNO, RURITAGE, SHERPA, SIMRA, UNISECO.

Topic: Creating conditions and facilitating the generation of wealth by rural communities

Issue – Over time, the communities of place in rural areas of Europe have been established, evolved, or ceased in the face of drivers of change. Opportunities have been sought to adapt and innovate, but economic, biophysical or cultural constraints have meant that it is not always possible for opportunities to be taken. Significant drivers have included the demand for natural resources (e.g. water, soil, minerals) and raw materials (food, fibre, timber), operating under different forms of governance, cultural influences (local and external), and the stimuli of innovation (product, technological, social). Communities of interest have grown (e.g. protection of natural and cultural heritage), and a diaspora of members of communities who migrated away, and which can become champions of areas, inward migrants and sources of external capital (economic and human).

Overall, the geographic places and patterns of habitation have been relatively stable over many generations. That is despite the economic and social activities of towns and villages changing dramatically, reflecting changes in the contexts for their establishment (e.g. cessation of fishing and conversion to tourism and centres of retirement; abandonment due to the completion (e.g. large scale development of transport, energy) or closure of industrial activities (e.g. mining, quarrying), leading to the removed need for local labour. Changes in population, demographic composition (age, gender, ethnicity), displacement, and patterns of inward and outward migration create pressures on services and infrastructure, including fewer innovations in the main economic sectors such as agriculture and forestry (German MAP; Schwarz and Stauß, 2021), as well as creating opportunities (e.g. new skills, ideas, motivations, creativity; e.g. Slovenia MAP; Erjavec and Rac, 2021). Changes in the nature of empowerment of communities can lead to new initiatives, investment and vibrancy (SIMRA; SMARTEES), of which the creative sector and availability of institutions conducting cultural activities or improving the condition of the historic environment can be a significant driver (e.g. Poland MAP; Chmieliński and Wieliczko, 2021).

Gaps in economic activity, opportunities and access to resources are increasing between rural and urban areas (e.g. Bulgaria MAP; Petko *et al.*, 2021). One key issue is that of the availability of rural housing which is affordable, and designed to be compatible with future requirements of: i) energy efficiency; ii) household and family size and composition; iii) enabling home working and learning for multiple members of a family. The process of providing new or upgraded housing can be a driver of rural development and prosperity.

Needs – To create or reinforce conditions within which community wealth can be generated from economic and social change. To identify how to influence positive behaviours of communities, including the actors who are the significant influencers in networks, such as through the creation of new frameworks (e.g. food policy councils, German MAP, Schwarz and Stauß, 2021; Regional Land Use Partnerships, UK MAPs, Miller *et al.*, 2021). To understand the timelines and spatial distribution of critical points in the use of resources in rural areas, and improve understanding of the links in value chains (UK MAPs, Miller *et al.*, 2021). To understand contemporary reasons for gaps between rural and urban areas, and identification of mechanisms that can aid them being bridged.

Example research question – What are the barriers, drivers and catalysts for wealth creation in rural areas? What are credible pathways to empowering communities within different forms of governance and cultural contexts? What mechanisms are required for innovation in rural communities to be fostered and realised?

Informed by H2020 Heartland, LIAISON, MAPS-LED, MATILDE, NEWBIE, QUANTMIG, ROBUST, SIMRA, SMARTEES SOCIALRES, TRANSIT.

Topic: Well-being economies of rural areas

Issue – The LTVRA envisages rural areas that are stronger, connected, resilient and prosperous. The focus is on place-based policies that facilitate territorial development. The concept of a well-being economy could provide one framework for the planning and management of rural areas, within their geographic areas of responsibility, with a focus on place-based policies. A change in emphasis in the framework within which the social, economic and natural resources of rural areas are valued, planned and managed (e.g. Poland MAP; Chmieliński and Wieliczko, 2021). Such emerging concepts could advance consideration of rural areas beyond the development of the resilience of rural areas to foster well-being. That would extend the discussion of governance and responsibilities for rural areas beyond the discussion of an economy of well-being (OECD, 2019), which noted channels through which economies of well-being can be built, and four elements of particular relevance of: Education and Skills; Health; Social Protection and Redistribution; and Gender Equality, although noting recommendations from other projects include culture and circulatory (e.g. ROBUST). Those elements should be ensured across life stages, and cognisant of them being direct or

indirect in nature (e.g. self- or tutored learning; distribution to individuals or through civil society groups). Account is also required of the meaning of "prosperity" to be wider than economic activity.

Issues to be understood are: i) the vulnerability of communities to changes in natural capital (e.g. climate change on occurrence of extreme events, financial instruments linked to natural capital) and social capital (e.g. outmigration, population aging); ii) the spatial definition of units for which types of governance have a remit; iii) identification of common pool resources, now and of the future; iv) effective means of enabling the bridging and dispersal of social capital.

Needs – To understand: i) how could a wellbeing economy, or alternative framework, deliver to the overarching vision of stronger, connected, resilient and prosperous; ii) relationships between natural capital, the functions, goods and services it provides, and the roles of those services for human wellbeing; iii) how a wellbeing economy can redress issues of inequalities (e.g. geographic, ethnic origin), and strengthen the delivery of education and skills; health and wellbeing care; and social protection; iv) how to exploit nature-based solutions and natural capital in their delivery of well-being economies. To improve the quality and spatial resolution of data on economic and social situations in rural areas (e.g. Slovenia MAP; Erjavec and Rac, 2021), and metrics relevant to understanding and monitoring a well-being economy (e.g. inequalities between peoples and places).

Example research question – What frameworks and concepts for the governance of rural areas are most likely to enable the aims of the EU LTVRA to be achieved, and the visions of those areas be elicited and realised?

Informed by H2020 AGRILINK, FARMWELL, MATILDE, POLIRURAL, ROBUST, RURITAGE, SHERPA, SmartAgriHubs, SIMRA, and ESPON ESCAPE.

Topic: Relationships between changes in consumer behaviours towards foods and diets and characteristics of rural areas

Issue – Changes in consumer behaviours towards foods and diets can contribute to policy objectives of transitions to net zero greenhouse gas emissions, sustainable food production, and the prosperity of rural areas. The provision of food for the whole population is a key role of rural areas, with associated obligations for the management of land and delivery of public goods (e.g. UNISECO), contributions to value chains, and a stimulus for entrepreneurship and innovations (e.g. SIMRA). To rebalance the position of the individual farmer as a key player in innovative food supply chains, requires an improved understanding of how to encourage young people (e.g. NEWBIE) in rural areas to co-create innovative solutions that enable farmers to address consumer needs and improve the conditions for the sustainable public procurement of local and seasonal food (e.g. COCOREADO).

One aim of the EU Farm to Fork Strategy is to produce "… a favourable food environment that makes it easier to choose healthy and sustainable diets that will benefit consumers' health and quality of life, and reduce health-related costs for society" (European Commission, 2020a). It recognises the need for a "transition to sustainable food systems, but that the transition will not happen without a shift in people's diets." One item in the portfolio of approaches required to transition to net zero GHG emissions is reducing the contribution from agriculture. Alongside changing land uses and farming practices, one key issue is the changing dietary preferences of consumers.

Changing the proportion of plant-based and low carbon food produced and consumed would contribute to both strategic aims (e.g. H2020 TRUE, FOODShift2030; Iannetta *et al.,* 2021). Such changes can be expected to have implications for uses of natural resources (e.g. impacts of changes in animal and plant-based diets on spatial and temporal demands for water), and thus the management and economies of rural areas. Associated issues are of rights to resources, needs for human capital for changes in production systems, the sustainability dimensions of the food chains (e.g. Vittuari *et al.,* 2021), understanding of drivers of changes

in dietary preferences, and of ensuring equality of access to, and affordability of, good quality food (nutritional value and taste).

Need – Research is needed to understand the: i) governance (public, private, third sectors), cultural, nutritional and societal impacts of moving beyond animal-based food systems (e.g. Morris *et al.*, 2021; InSPIRES); ii) barriers (e.g. cultural, regulatory, legal, supply) to the introduction and uptake of agri-food products into dietary preferences and habits of consumers and a regional food economy (Italy Emilia Romagna MAP, Targetti and Pellegrini, 2021); iii) place-based approaches for food systems based on agro-ecological principles, outputs from which have been produced with respect to people, environment and nature (Lithuania MAP; Gedminaite-Raudone and Vilke, 2021); iv) potential of, and strategies for, enhanced producer-consumer links to support dietary change to seasonal and healthy food (German MAP; Schwarz and Stauß, 2021); v) synergies and trade-offs between characteristics of visions for rural areas that relate to transitions in food systems; vi) most effective means of raising public awareness of the resources required for the production of foods typically found in diets, and their impacts on climate and natural resources.

Example research questions – What are the synergies and trade-offs between resilient and prosperous rural areas under changes in human diets and food supply chains? What are the multiple benefits of low carbon food landscapes of the future?

Informed by H2020 COCOREADO, FarmersPride, FOODEV, FOODe, FOODLAND, FOODShift2030, Heartland, LIAISON, LIFT, InSPIRES, NEWBIE, SavingFood, SMARTCHAIN, STRENGTH2FOOD, SUSFOOD2, TRUE, UNISECO.

Topic: Supporting the sustainability of digitalisation

Issue – The progressive evolution of infrastructure that enables digital connectivity, activities and solutions is creating new opportunities for working or living in, and visiting, rural areas. For example, digital technologies are evolving and being implemented that can inform the understanding, and enhancement of the resilience and capabilities of supply chains in rural areas (e.g. raw materials, food, retail products), production processes and automation (Hungary MAP, Kis *et al.*, 2021a), with new digital modes of interactions amongst value chain actors adapted to consumer needs and attitudes. Changes in the cyber domain affect those in the social domain (e.g. new networks and relations between actors; DESIRA, Rijswijk *et al.*, 2021).

The rates of development of physical infrastructure (cable, radio, satellite), digital tools (e.g. hardware and software), human capital (e.g. skills), and equality of access to digital infrastructures differ across countries and regions. The design of roll-out of that infrastructure will recognise the requirements for the creation of frameworks, early adopters, and scaling out. However, in each case, the timescales for roll-out will vary for one or more of the requirements for digitalisation (e.g. needs identified in France MAP; Rolland *et al.*, 2021). A consequence is that some people and places will not be able to participate in the opportunities, and risks, linked to digitalisation and the proposed **LTVRA flagship initiative of digital rural futures**.

Amongst risks that digitalisation could pose for rural areas is the externalisation of services, with losses of the relevance of local knowledge or impacts of loss of awareness of the significance of characteristics of nature or cultures that are local to an area (e.g. Spain Aragon MAP, Folkeson and Bardají, 2021). A further risk is that of misuse or criminal use of digital infrastructure, including risks to users of digital tools (e.g. new providers of data; civil and business reliance on digital data) of cyber-criminals, and unethical uses of data (e.g. misuse of artificial intelligence and analytics) for actions for which regulations and laws have not been designed or implemented.

Needs - Alongside the evolution of digitalisation is how it can be sustained. That includes understanding the evolution of digital infrastructures that are enabling and empowering (directly or indirectly), with accompanying needs for safe digitalisation. Development of digital technologies that understand and enhance

the resilience and capabilities of supply chains in rural areas (e.g. raw materials, food, retail products); understanding of the barriers to uptake by business, civil society, individuals (e.g. cultural, financial, technical), and inequalities of access or uptake (e.g. gender, age, abilities). Understanding environmental impacts of improved digital connectivity in rural areas, including: i) reductions in emissions of GHGs; ii) recycling of materials (e.g. plastics, metal compounds). Identification of the performance indicators most appropriate for digitalisation, and associated indicators to raise alerts of where and who is "being left behind".

Informed by H2020 AgTECH, AURORAL, DESIRA, FAIRShare, RURITAGE, SIMRA.

Topic: Systems approaches to Integrated Pest Management with land management

Issue – Changes in agricultural practices, such as transitions to agro-ecological farming systems, will lead to reductions in the use of agrochemicals in line with aims of a circular economy, Biodiversity 2030 Strategy, (European Commission, 2020b) and Farm to Fork Strategy (e.g. reducing pesticide use and risk by 50% by 2030; European Commission, 2020a), associated with challenges arising from climate change, and the loss of biodiversity on the development of plant disease. Crop production will have to be resilient to factors associated with climate change (e.g. water stress, disease), raising questions relating to needs and methods for new crops and plant breeding (e.g. genetic modification, gene editing; e.g. Portugal MAP; Santos and Mendes, 2021; Spain Galicia MAP, Guimarey *et al.*, 2021; Poland MAP; Chmieliński and Wieliczko, 2021), using farming practices and systems which limit exposure to risks and increase scope for delivering other benefits (e.g. biodiversity, agrobiodiversity), and knowledge required for more effective use of agrobiodiversity for preserving biodiversity and related ecosystems, and benefits of reduced dependency on use of chemical pesticides and fertilisers in agriculture.

The systems approach requires account to be taken of the purposes for which land is used (farming, forestry, designated or protected areas, managed historic sites), practices for its management (including transitions to organic or agro-ecological systems), place (e.g. consistency with traditional approaches), scale (e.g. landscape), people (e.g. collaborative approaches between neighbours, land managers within a water catchment, territorial unit), and monitoring (e.g. earth observation, drones, Copernicus Services). Addressing this issue also contributes to the project proposed in the Rural Action Plan of a study on land use linked to sustainable farming.

Need – Systems-based strategies to manage risks to crops with reduced reliance on agrochemicals, and increased roles for agro-ecological farming practices, taking account of current and future farming practices and the contexts of surrounding land uses (e.g. Spain Galicia MAP; Guimarey *et al.*, 2021). Improved understanding of interdependencies of technological, organizational and institutional innovations necessary to overcome reasons behind underutilisation of agro-ecological practices, and thus enhance agrobiodiversity. New skills and effective means of sharing knowledge will require to be learnt for planning and implementing Integrated Pest Management for its effective use across landscape and territorial scales, in different biophysical and cultural contexts.

Example research question – What are effective Integrated Pest Management strategies for minimising risks to crops due to changes in farming systems and practices that are consistent with the aims of the EU Biodiversity 2030 Strategy (European Commission, 2020b) and Rural Action Plan.

Informed by H2020 CAPSELLA, C-IPM, Diversify, EcoStack, FarmersPride, Heartland, IPMWorks, LIFT, Pesteffect, SPRINT, UNISECO, and consistent with the prospective EU Partnership on Agroecology.

Topic - One Health approach to developing strategies for antimicrobial stewardship

Issue – The EU Farm to Fork Strategy notes the "urgent need to reduce the dependency on pesticides and antimicrobials and excess fertilisation …" (European Commission, 2020a). The World Health Organisation

notes the issue crosses sectors of rural interests "and stakeholders engaged in human, terrestrial and aquatic animal and plant health, food and feed production and the environment."

Increased antimicrobial resistance (AMR) emerges in water, soil and air due to misuse and overuse of antimicrobials, and due to: lack of access to clean water, sanitation and hygiene for humans and animals; poor infection and disease prevention and control in health-care facilities and farms; poor access to quality, affordable medicines, vaccines and diagnostics; lack of awareness and knowledge; and lack of enforcement of legislation (World Health Organisation, 2021; European Centre for Disease Prevention and Control). However, the rates of change in adopting and implementing steps that would reduce risk of AMR vary across the EU, and are "neither linear nor homogeneous" (Farm to Fork Strategy; European Union, 2020a) but about which no data have been synthesised or reported. Responses to COVID-19 have complicated the use of antimicrobials and their supply chains. There is a need for data on what, where and when antimicrobials are being used, with associated environmental data on residual concentrations (Knight *et al.*, 2021).

Need – Strategies and action plans on antimicrobial stewardship programmes in rural and remote settings, and preparation for future pandemics, and understanding of development, transmission, and impact across the interface of human, animal, and environmental reservoirs. To inform such strategies and action plans, there is a need for a territorial assessment of the risks of sources of antimicrobial bacteria, including the perceptions of rural stakeholders (e.g. healthcare and veterinary professionals), as part of wider risk management strategies for the environment, agriculture and waters (Poland MAP; Chmieliński and Wieliczko, 2021). Such strategies could contribute to the project proposed in the Rural Action Plan of a study on land use linked to sustainable farming.

Example research questions – What risks are posed to the pathways to sustainable agriculture by increased antimicrobial resistance? What are the consequences for territorial development of inequalities in access to high quality mechanisms of disease prevention and treatment, and knowledge and best practices?

Informed by H2020 COMPARE, PREPARE, ROADMAP, MOOD; Joint Programming Initiative on Antimicrobial Resistance (JPIAMR); consistent with the EU Soil Mission, soils pollution and restoration, and findings from research outwith Europe (e.g. Australia, Yau *et al.*, 2021; USA, Bulteel *et al.*, 2021).

Topic: Observation, monitoring and reporting

Issue – As H2020 and Horizon Europe projects deliver open data in line with principles of open science, so the types and volume of data available for use by interested parties (e.g. citizens, civil society groups, business, policy) can be expected to increase significantly. Projects expected to be funded through recent calls in Horizon Europe (e.g. H2020-LC-GD-10-3-2020, Enabling citizens to act on climate change and for sustainable development through better monitoring and observing of the environment and their environmental impacts) should contribute to this issue. However, there is still likely to be a need to identify and understand barriers to uptake of opportunities enabled by Open Data and Science, and the Copernicus Services, with a view to their use in engaging citizens (e.g. improving knowledge of soils within the proposed EU Mission on soil health and food envisaged in the LTVRA), and dialogue between different parties (e.g. producers, local governments, citizens; Netherlands MAP; Groot and Vermue, 2021). Emerging tools and capabilities using the micro-satellites for earth observation, internet of things, artificial intelligence, analytics and big data provide new opportunities, including for citizens, for scaling out the measurement, monitoring and reporting of characteristics of the environment, and its uses. Capabilities for taking account of issues of data quality are likely to be more limited amongst communities and citizens than businesses, public bodies and research organisations.

Such limited capabilities may be a characteristic of places where the knowledge is needed. Examples of gaps in data identified by MAPs were: i) High Nature Value areas, with knowledge gaps, poor natural conditions, fragmented ownership, unfavourable demographic and educational structure of farm holders (Slovenia MAP, Erjavec and Rac, 2020); ii) migration, use of mobile communications, multi-locality living, indicators of well-

being for use in local planning (Finland MAP; Kull *et al.*, 2021); iii) mechanisms that enable the sharing of knowledge, systems of measurement, and monitoring between countries which are further developed in those practices than others (Czechia MAP, Krist *et al.*, 2021).

FAIR principles of open data (Wilkinson *et al.*, 2016) primarily reflect a supplier perspective. Attention should be given to user perspectives and the human and technical capabilities for access and use of data (data justice), and broadening the capabilities of prospective users who can link data from different sources.

Needs – To ensure open data relating to rural areas, delivered through H2020 and Horizon Europe projects, are provided with quality assessments of relevance (e.g. positional, relative, topological and referential accuracy), and in compliance with all ethical requirements. The quality of data obtained from new sources of data for environmental monitoring (e.g. observations from micro-satellites, citizen science, environmental sensors) should be tested and proven, and have clear pathways for use by science, society and policy advice.

Data of known quality will contribute to the credibility and usability of the Rural Observatory proposed in the Rural Action Plan and the use and uptake of data on rural areas disseminated from this source, and in turn the resources available to the proposed **LTVRA flagship initiative of a rural revitalisation platform**. Effective means of communicating data relating to rural areas, and narratives about rural areas, such as visualisation tools (e.g. Finland MAP, Kull *et al.*, 2021; Netherlands MAP; Groot and Vermue, 2021; Denmark MAP, Refsgaard and Ormstrup Vestergård, 2021).

Alongside capabilities for observation and monitoring there is a need for data and tools for modelling (e.g. social, economic and natural processes), and means of exploring new streams of data and representations of the physical world through computational sciences (e.g. digital twins, augmented reality, gamification).

Example research question – What are the impacts of data quality, and uncertainty, on the usability of data by citizens and civil society in the processes of empowered rural communities, as envisaged in the LTVRA? What are the most effective ways of providing information that will enable the interpretation of social, economic and environmental state and changes in ways that are meaningful to communities of place in rural areas, and of communities of interest?

Informed by conclusions of SHERPA Position Paper on landscape features (Mottershead *et al.*, 2021); projects funded under H2020-SWAFS-2019 Citizen Science (e.g. MICS, ACTION) and E-Infrastructures (H2020-EINFRA-2016-2017) and MSCA-IF-2018 (e.g. GRACE).

6.   Alignment with Research Strategies

The identification of research gaps and agendas are primarily based on the MAPs of the SHERPA project structure. Their thematic and geographic extents and contexts set boundaries on the topics of the research agendas identified, and thus do not represent a comprehensive coverage of all aspects of evidence required to inform policy and society in rural areas of Europe. The basis for identification of the areas of research reflects the composition of the MAPs, drawn from policy, society and science. Therefore, there is an element of demand expressed through the visions or desired positions, and insights to the availability of scientific evidence and gaps in knowledge. The research areas are not defined exactly, thus the intersections with other priorities or strategies, as noted below, are indicative and interpretations.

The research agenda of *Observation, monitoring and reporting*, intersects all 4 orientations. That reflects roles identified by the MAPs and related EU projects of open science and data, broadening involvement of citizens in the processes of observing and reporting characteristics of rural areas, and use of automated technologies. Aspirations were identified for creating communities with a capacity to adapt to changing circumstances, and an eagerness to contribute to its evolution (e.g. Greece MAP; Nicoleta and Evangelos, 2021). Realising that desire could be enabled by mechanisms for addressing the research agendas identified can contribute to the creation of an innovative ecosystem in Europe. Such mechanisms would involve stakeholders participating in research and innovation in rural areas. This would require bringing together

"public and private players for rural communities to thrive, and be an attractive place for innovators to work and live" (European Commission, 2021b). An outcome could be to extend the **LTVRA flagship initiative envisaged of research and innovation for rural communities** to one that is with rural communities.

New or improved means of observing, monitoring and reporting of rural areas will contribute to the aims of the EU in Open Science Policy and the delivery of outputs from all projects to the FAIR principles (Findable, Accessible, Interoperable and Re-usable data; Wilkinson *et al.*, 2016), and increased use of the European Open Science Cloud to enable researchers to store, curate and share data. Such observations need not be restricted to quantitative information, with recording that is qualitative in nature offering descriptive data, and insights to attitudes, opinions and reactions to both state and changes in state through time.

The eight research topics would contribute to one or more of the four strategic orientations of the Horizon Europe Programme (European Commission, 2021a) for 2021 to 2024 (Table 1). The intersections of topics with more than 1 strategic orientations reflects, in part, the nature of the relevance of the research to rural areas, such as the combination of elements that might be expected under the heading of a digitally enabled circular, climate-neutral and sustainable economy.

In addressing the 4 strategic orientations, all 8 research agendas proposed by SHERPA include some aspects of the development of digital infrastructure, tools, data and uses. It is also consistent with the European Commission priority of "A Europe fit for the Digital Age", with roles for artificial intelligence (e.g. agendas Supporting the sustainability of digitalisation; Observation, monitoring and reporting); European Data Strategy (European Commission, 2020c) (e.g. agendas *Creating conditions and facilitating the generation of wealth by rural communities*, recognising evolution of digital health and improved mobility; *Observation, monitoring and reporting*, recognising principles of FAIR data (Wilkinson *et al.*, 2016); and *Supporting the sustainability of digitalisation*, recognising the essential requirements of data protection); and cyber-security (e.g. skills and knowledge of users to protect their data, identity, assets; regulations entitling protection).

Alongside the evolution of these technological innovations are the needs to broaden the base of users, including advisors (e.g. agriculture, forestry), animateurs (e.g. community development), and the development of skills within the rural population, across life stages. At all times, those innovations require to be within frameworks that ensure ethical uses of equipment and data (e.g. observations of the resources of others), and equitability of rights of access by all sectors of society.

The research needs identified through the SHERPA process appear to resonate with a subset of eight of the proposed European Partnerships under Horizon Europe (DG Research and Innovation, 2020) (Table 2). As with the overarching orientations of the Horizon Europe programme (European Commission, 2021a), advancing the means of observation, monitoring and reporting is expected to be of importance to the 8 partnerships to which the research appears likely to be relevant. The research topics are also consistent with the expectation of the synergies in these partnerships. In different combinations, the research areas cross business and land management sectors, recognising the need and benefits of more evidence of what and how to use nature-based solutions (e.g. soils, plants) in managing land. The effective exploitation of that evidence can aid improvements in processes throughout supply and value chains, and for the places within which the nodes in those chains operate (e.g. biodiversity, social equality).

Table 1. Mapping topics of SHERPA research agenda onto Strategic Aims of Horizon Europe Programme

Horizon Europe Strategic Orientation*	Research Topics							
	Planning coherent, equitable, multi-functional land uses	Creating conditions and facilitating the generation of wealth by rural communities	Well-being economies of rural areas	Relationships between changes in consumer behaviours towards foods and diets and characteristics of rural areas	Supporting the sustainability of digitalisation	Systems approaches to Integrated Pest Management with Land Management	One Health approach to developing strategies for antimicrobial stewardship	Observation, monitoring and reporting
Open strategic autonomy		X			X			X
Restoring Europe's ecosystems and biodiversity	X			X		X	X	X
Digitally enabled economy	X	X	X	X	X		X	X
Resilient, inclusive democratic society	X	X	X		X			X

*Note: Strategic aims of Horizon Europe, in full: i) Promoting an open strategic autonomy by leading the development of key digital, enabling and emerging technologies, sectors and value chains; ii) Restoring Europe's ecosystems and biodiversity, and managing sustainably natural resources; iii) Making Europe the first digitally enabled circular, climate-neutral and sustainable economy; iv) Creating a more resilient, inclusive and democratic European society.

Table 2. Mapping topics of SHERPA research agenda onto prospective European Partnerships (DG Research and Innovation, 2020).

	Research Topics							
Prospective European Partnerships	Planning coherent, equitable, multi-functional land uses	Creating conditions and facilitating the generation of wealth by rural communities	Well-being economies of rural areas	Relationships between changes in consumer behaviours towards foods and diets and characteristics of rural areas	Supporting the sustainability of digitalisation	Systems approaches to Integrated Pest Management with Land Management	One Health approach to developing strategies for antimicrobial stewardship	Observation, monitoring and reporting
One Health/ Antimicrobial Resistance			X			X	X	X
Artificial Intelligence, Data and Robotics					X			X
Accelerating farming systems transition: agroecology living labs, research infrastructures	X	X	X	X		X		X
Agriculture of Data (environmental observations	X				X	X		X

for sustainable EU-agriculture)								
Rescuing biodiversity to safeguard life on Earth	X	X	X	X		X		X
Safe and Sustainable Food System	X			X		X		X
Circular bio-based Europe	X	X			X			X
Open Science Cloud Partnership	X	X	X	X	X	X	X	X

The research areas identified also intersect with 4 areas identified by the SCAR-AKIS Foresight Group (Brunori *et al.*, 2020; Table 3). The Foresight Group note that within the EU there is underperformance on "… social measures, such as income equality, education, healthy life expectancy and nutrition", excess inputs to the environment (e.g. nitrogen), and the inter-connectedness of issues, exacerbated by the COVID-19 pandemic. In that same context, there are themes that are common to several of the research agendas identified from the SHERPA process, notably equality, well-being, and systems approaches. These intersect the agri-food remit of the SCAR-AKIS with the wider scope of SHERPA across rural areas, for example linking food, well-being and society with the planning of coherent, equitable and multi-functional land uses, and the concept of well-being economies of rural areas. The two perspectives recognise the importance of innovation, both social (e.g. on the provision of societal good through generation of wealth for rural communities, and the well-being of communities), and technical (e.g. digital transformations), and the connectedness of the two.

The topic areas identified by the SHERPA MAPs as priorities also align with the remits for research recommendations of two of the 5 Horizon Europe Missions (adaptation to climate change including societal transformation, and Soil Deal for Europe on transition towards healthy soils), and to a lesser extent that of healthy oceans, seas coastal and inland waters. Similarly, the research areas reflect the need for inter- and transdisciplinary working, as stated in the Soil Health Mission (DG Research and Innovation, 2021).

The recommendations for research agendas have prospective contributions to make to the 4 areas of action of the EU LTRVA, an indication of which is summarised in Table 4. In all cases there is a need for inter- or transdisciplinary approaches of research which facilitate multiple perspectives on the areas of action.

An outcome of understanding the prospective future functions of land, and the changes in natural, social and economic processes required to achieve them (i.e. planning of coherent, equitable, multi-functional land uses) can contribute towards the aims of all 4 areas of action. New knowledge would improve the means of undertaking place-based approaches to planning and zoning of land use, and the provision of services of the future, and increasing the **resilience**, **well-being** and **prosperity** of rural communities.

Similarly, all 4 areas of action are aided by supporting the sustainability of digitalisation creates the basis for designing effective and accessible technical and social aspects of digital infrastructure (e.g. apps that inform carbon-friendly actions; improve human capital in terms of digital literacy). Enhanced knowledge of how digitalisation **empowers** individuals and communities should contribute to **stronger rural areas**, but in ways that are safe and responsible (from the perspectives of the enabling technologies, and for and by users), and thus also consistent with the principles of the European Pillar of Social Rights of supporting people in need. The availability of performance indicators of the processes of digitalisation (including physical, mobile and satellite **connectivity)** in rural areas should be an important element in strategies for ensuring the equity of digital transitions, social resilience and how it facilitates prosperity, and dimensions of community **well-being** (e.g. social cohesion, evidence of equalities).

To achieve the aspirations set out in the EU Farm to Fork Strategy in the timescales set (e.g. to reduce the overall use and risk of chemical pesticides by 50%, the use of more hazardous pesticides by 50% by 2030, and the use of fertilisers by at least 20% by 2030; European Commission, 2020a) will require greater understanding of the current state and transitions in systems of land management. Such insights can inform actions that increase the **resilience** of places and land-based businesses to natural hazards and impacts of climate change (e.g. through nature-based solutions). Similarly, A better understanding of the relationships between changes in consumer behaviours towards foods and diets and characteristics of rural areas, would enable planning and building capacities designed to add value to farming and agri-food activities under contexts of policy and societal responses to **climate change, and sustainable food production.**

Table 3. Mapping topics of SHERPA research agenda onto the cross-cutting research themes identified by the SCAR-AKIS Foresight Exercise Expert Group (Brunori *et al.*, 2020).

Cross-cutting Research Themes	Research topics							
	Planning coherent, equitable, multi-functional land uses	Creating conditions and facilitating the generation of wealth by rural communities	Well-being economies of rural areas	Relationships between changes in consumer behaviours towards foods and diets and characteristics of rural areas	Supporting the sustainability of digitalisation	Systems approaches to Integrated Pest Management with Land Management	One Health approach to developing strategies for antimicrobial stewardship	Observation, monitoring and reporting
Food, well-being and society	X		X	X		X	X	X
Social innovation		X	X		X			X
Agro-ecology	X	X		X		X	X	X
Digital transformation of the bioeconomy	X	X			X			X

Table 4. Mapping topics of SHERPA research agenda onto the action areas of the EU Long Term Vision for Rural Areas (European Commission, 2021b).

Rural Action Plan – Areas of Action	Research Topics							
	Planning coherent, equitable, multi-functional land uses	Creating conditions and facilitating the generation of wealth by rural communities	Well-being economies of rural areas	Relationships between changes in consumer behaviours towards foods and diets and characteristics of rural areas	Supporting the sustainability of digitalisation	Systems approaches to Integrated Pest Management with Land Management	One Health approach to developing strategies for antimicrobial stewardship	Observation, monitoring and reporting
Stronger rural areas	X	X	X		X			X
Connected rural areas	X			X	X			X
More resilient rural areas that foster well-being	X	X	X	X	X	X	X	X
Prosperous rural areas	X	X		X	X	X	X	X

Understanding how to integrate the management of pests into the wider management of farming, forestry, and natural ecosystems could also enable the planning of beneficial relationships with other land uses (at scales from site to landscape), and their characteristics such as farm infrastructure (e.g. trees, hedges, water courses used as field boundaries). Evidence of interactions within land systems should inform strategies and development of human capital that avoid unknown or unintended consequences (e.g. the removal of landscape features that had contributed to sense of place or environmental heritage). As such, improved knowledge, and demonstration, of systems approaches to integrated pest management would have beneficial impacts on the sustainability of products of food and nature, and the **prosperity** of rural areas.

Similarly, as the direct and indirect impacts of the COVID-19 pandemic continue to emerge, so do appreciation of the importance of a stable and equitable relationship between people and nature. Rapidly required decisions and subsequent actions may result in unintended consequences for rural areas, evidence of which will take time to emerge. For several generations, antimicrobial drugs have had highly significant roles in tackling infectious disease, protecting natural resources and the environmental, and supporting food security. Increased resistance to antimicrobials could have significant social, economic and environmental impacts. Development of strategies for antimicrobial stewardship could improve environmental and human **resilience** in rural areas, and contribute to the **sustainability** of food production.

The creation of new knowledge also aligns with aims for research and innovation for rural communities (e.g. knowledge hubs; "digital acceptability laboratories", France MAP; Rolland *et al.*, 2021), and opportunities supported by innovation, which also supports knowledge sharing and cooperation between actors. Reference is made to monitoring of the situation of rural areas, and monitoring and reporting of achievement towards 2040. However, there is no explicit information on indicators that might be appropriate for use in tracking how availability of new knowledge, through Open Science, will aid the achievement of the aims of the LTVRA.

The SHERPA MAPs recognised the importance of understanding the relationships between changes in natural capital, economic growth, employment, and its role in the concept of a well-being economy. Development of such a concept could provide a different way of viewing the resilience of people and places, and the relationships between natural, social, human and economic capitals. In turn that could offer new bases for rewarding the investments required in tackling climate change (e.g. returns from building carbon sinks through peatland restoration), and interpretation of the wealth and prosperity of rural areas, and thus also the proposed **LTVRA flagship initiatives of building up carbon sinks**, and the **EU mission on soil health and food.** Understanding the formation, bridging and dispersal of social capital can contribute to the planned **LTVRA flagship on Research and Innovation in Rural Communities.**

Alongside the tackling of research challenges, is a requirement for transforming the provision and uptake of research knowledge, tools and data to improve the quality of planning for and decisions taken for developing rural areas that are attractive places within which to live, work and recreate. That requires mechanisms of translating research findings into uses at strategic, tactical and operational levels, and the engagement and cooperation of a wide range of actors at the EU, national, regional and local level. To achieve that translation in turn requires research into how to improve "the knowledge transfer through advisory services and other rural multipliers" (Romania MAP; Brumă and Tudor, 2021; Hungary MAP, Kis *et al.*, 2021b), and the creation of professions relevant to the futures of rural areas (e.g. France MAP; Rolland *et al.*, 2021).

The synthesis of outputs from the SHERPA MAPs provides an intermediate step in the development of the needs of policy and society in relation to the visions and management of rural areas, and thus the states desired. In turn, these represent indicative impacts to which research can be expected to contribute (e.g. conceptually, operationally, instrumentally). The research agendas would need to be accompanied by engagement with stakeholder communities for the development of recommendations on the types of information (quantitative and qualitative) that would be appropriate to collect for evaluating the impacts of the research. In particular, transformations should support the democratisation and equity of decision-making about rural areas. A desirable outcome of these research agendas would be a transition in capabilities of all sectors of actors in rural areas within governance structures that enable the co-discovery, co-creation

and co-implementation of local strategies for rural areas (Romania MAP; Brumă and Tudor, 2021). One indicator of such a transition would be an increased proportion of the research being led by rural actors and delivered within, as well as with and of, rural areas.

7.   Conclusions

In the first 24 months of SHERPA, the topic of principal focus was that of long-term visions for rural areas, and a pilot of the SHERPA process conducted on protecting and enhancing biodiversity through landscape features. A synthesis of the recommendations, visions and gaps in knowledge identified in the SHERPA Position and Discussion Papers led to the identification of eight areas for research, listed below:

- Planning coherent, equitable, multi-functional land uses
- Creating conditions and facilitating the generation of wealth by rural communities
- Well-being economies of rural areas
- Relationships between changes in consumer behaviours towards foods and diets and characteristics of rural areas
- Supporting the sustainability of digitalisation
- Systems approaches to Integrated Pest Management with Land Management
- One Health approach to developing strategies for antimicrobial stewardship
- Observation, monitoring and reporting

All the research areas have one or more intersections with strategic research needs identified by the EU in its development of the overall orientations of the Horizon Europe programme (European Commission, 2021a), and the candidate topics of the European Partnerships (DG Research and Innovation, 2020). Several also align with prospective recommendations for research of Horizon Europe Missions (European Commission, 2021a).

The gaps in evidence or knowledge identified from the SHERPA process provides a synthesis of supply and demand led perspectives. They reflect where there are weaknesses in the current evidence base, and topics within which there are likely to be needs for future knowledge. Each of the areas of needs for knowledge align with 2 or more of the areas of action in the Rural Action Plan of the LTVRA (European Commission, 2021b).

Findings relevant to addressing these research Topics can also be expected to emerge from existing projects, and those from EU H2020 or Horizon Europe calls that are yet to be commissioned. In turn, those will help move the research agendas forward, as will the knowledge created and requirements for new evidence. Some of that evolution of needs and evidence will inform the second set of research agendas to be identified by SHERPA, scheduled for September 2023. As the SHERPA project matures and reports on its final phases, so the processes, benefits and research questions relating to the forms of governance and institutional arrangements for transdisciplinary research and ways of working, and mechanisms such as Multi-Actor Platforms.

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10. ANNEXES

ANNEX 1. Enablers of rural visions covered by Horizon Europe Calls for proposals focusing on rural areas

Type of Action	Project Title	Basic services and infrastructure	Climate, environment and sustainability	Smart rurality and Digitalisation	Governance and participation	Knowledge, data, and images	Rural economies	Social capital	Foresight
HORIZON Coordination and Support Actions	Grasping rural diversity and strengthening evidence for tailored policies enhancing the contribution of rural communities to ecological, digital and social transitions		x		x	x	x		
HORIZON Research and Innovation Actions	Expertise and training centre on rural innovation	x	x	x	x		x	x	
HORIZON Research and Innovation Actions	Smart XG, last-mile and edge solutions for remote farming, forestry and rural areas	x	x	x	x	x	x		
HORIZON Coordination and Support Actions	Mainstreaming inclusive small-scale bio-based solutions in European rural areas		x			x	x		
HORIZON Coordination and Support Actions	Improving national AKIS organisation in a co-creative process across the EU				x	x		x	

Type	Description							
HORIZON Research and Innovation Actions	Supporting knowledge exchange between all AKIS actors in the Member States by means of an EU-wide interactive knowledge reservoir				x		x	
HORIZON Coordination and Support Actions	Deepening the functioning of innovation support	x	x			x	x	
HORIZON Coordination and Support Actions	Developing EU advisory networks on consumer-producer chains	x			x	x		
HORIZON Coordination and Support Actions	Thematic networks to compile and share knowledge ready for practice		x		x	x		
HORIZON Research and Innovation Actions	Assessing the impacts of digital technologies in agriculture – cost, benefits and potential for sustainability gains	x	x			x		
HORIZON Coordination and Support Actions	Mobilising the network of national contact points in Cluster 6	x		x				
HORIZON Research and Innovation Actions	Modelling land use and land management in the context of climate change	x		x	x			
HORIZON Research and Innovation Actions	Data economy in the field of agriculture – effects of data sharing and big data	x	x		x	x		

Type	Title								
HORIZON Research and Innovation Actions	Potential of drones as multi-purpose vehicle – risks and added values		x	x	x	x	x		
HORIZON Research and Innovation Actions	Resilient livestock farming systems under climate change		x				x		x
HORIZON Research and Innovation Actions	EU agriculture within a safe and just operating space and planetary boundaries		x		x	x			
HORIZON Research and Innovation Actions	Development of the markets and use of digital technologies and infrastructure in agriculture – state of play and foresight: digital and data technologies for the agricultural sector in a fast changing regulatory, trade and technical environment	x	x	x		x	x		x
HORIZON Research and Innovation Actions	Towards an EU approach to assess and internalise positive and negative externalities of food for incentivising sustainable choices		x		x	x			
HORIZON Research and Innovation Actions	EU-China international cooperation on integrated pest management in agriculture		x						
HORIZON Research and Innovation Actions	Furthering food systems science and federating researchers across the European Research Area		x			x	x		x

HORIZON Research and Innovation Actions	Towards a new normal? Employment and social impacts of changing supply chains and declining trade intensities		x			x	x		
HORIZON Research and Innovation Actions	Filling knowledge gaps on the nutritional, safety, allergenicity and environmental assessment of alternative proteins and dietary shift		x		x	x			
HORIZON Research and Innovation Actions	Tackling outbreaks of plant pests		x			x	x		
HORIZON Innovation Actions	Digital transition supporting inspection and control for sustainable fisheries		x	x					
HORIZON Coordination and Support Actions	Circular Cities and Regions Initiative's project development assistance (CCRI-PDA)		x				x	x	
HORIZON Innovation Actions	Circular Cities and Regions Initiative (CCRI)'s circular systemic solutions		x				x	x	
HORIZON Innovation Actions	Smart solutions for smart rural communities: empowering rural communities and smart villages to innovate for societal change	x		x	x	x	x	x	
HORIZON Research and	Boosting women-led innovation in farming and rural areas				x			x	x

Innovation Actions										
HORIZON Innovation Actions	Piloting innovative governance solutions to limit nitrogen and phosphorus emissions at the interface of rural/coastal and urban/industrial environments		x		x					
HORIZON Coordination and Support Actions	Improving preparation of multi-actor projects to enable the relevant actors to work in a co-creative way			x	x					
HORIZON Coordination and Support Actions	Developing EU advisory networks on water use		x		x					
HORIZON Coordination and Support Actions	Thematic networks to compile and share knowledge ready for practice			x	x	x				
HORIZON Coordination and Support Actions	Thematic networks to compile and share knowledge ready for practice			x	x	x				
HORIZON Coordination and Support Actions	Broaden EIP Operational Group outcomes across borders by means of thematic networks, compiling and sharing knowledge ready for practice		x	x		x				

HORIZON Coordination and Support Actions	Broaden EIP Operational Group outcomes across borders by means of thematic networks, compiling and sharing knowledge ready for practice		x	x		x			
HORIZON Innovation Actions	Maximising economic, environmental and social synergies in the provision of feedstock for bio-based sectors through diversification and increased sustainability of agricultural production systems		x			x	x		
HORIZON Research and Innovation Actions	AU-EU Water Energy Food Nexus		x		x	x			
HORIZON Research and Innovation Actions	EU-China international cooperation on unlocking the potential of agricultural residues and wastes for circular and sustainable bio-based solutions		x			x	x		
HORIZON Innovation Actions	Marginal lands and climate-resilient and biodiversity-friendly crops for sustainable industrial feedstocks and related value chains		x		x		x		
HORIZON Research and	African food cities								

Innovation Actions									
HORIZON Coordination and Support Actions	Innovative tools and methods to evaluate the design and support, monitoring and implementation of effective CAP strategic plans		x		x				
HORIZON Innovation Actions	Building alternative protein-friendly sustainable and healthy food environments		x					x	
HORIZON Innovation Actions	Innovative food from marine and freshwater ecosystems		X						
HORIZON Research and Innovation Actions	Assessing the socio-politics of nature-based solutions for more inclusive and resilient communities		X		x	x	x	x	
HORIZON Coordination and Support Actions	Support the deployment of lighthouse demonstrators for the New European Bauhaus initiative in the context of Horizon Europe missions		X						

ANNEX 2. Summary of FP7 and Horizon Europe projects that contribute to enablers of rural visions

Type of Action	Basic services and infrastructure	Climate, environment and sustainability	Smart rurality and Digitalisation	Governance and participation	Knowledge, data and images	Rural economies	Social capital
Number of projects	12	60	52	33	89	139	39
Maximum EC Contribution (Euros)	32,465,153	238,348,780	176,347,800	96,513,144	226,247,735	417,570,711	135,969,062