DIGITISATION: ECONOMIC AND SOCIAL IMPACTS IN RURAL AREAS

COMPARATIVE SCENARIO REPORT

FEBRUARY 2022

DOMINIC DUCKETT, MARGARET CURRIE, BOELIE ELZEN, CLAIRE HARDY, CHRISTINA NOBLE, LEANNE TOWNSEND

DESIRA receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818194.

SCENARIO PLANNING COMPARATIVE SYNTHESIS REPORT

Project name	**DESIRA | Digitisation: Economic and Social Impacts in Rural Areas**
Project ID	818194
H2020 Type of funding scheme	Research and Innovation Action (RIA)
H2020 Call ID & Topic	H2020-RUR-2018-2 / RUR-02-2018 Socio-economic impacts of digitisation of agriculture and rural areas
Website	www.desira2020.eu
Document Type	Deliverable
File Name	WD 3.2. DESIRA Scenario Planning Comparative Synthesis Report
Status	Final
Authors	Dominic Duckett, Margaret Currie, Boelie Elzen, Claire Hardy, Christina Noble, Leanne Townsend
Work Package Leader	James Hutton Institute
Project Coordinator	UNIPI

1. Executive Summary

- In DESIRA, scenario planning was carried out with all LLs to understand the possible future implications of digitalisation across three rural domains – agriculture, forestry and broader rural community development. In DESIRA we co-constructed scenarios 10 years in the future with the LLs. The scenario workshops, as well as the analysis of country-level reports presented in this synthesis report, follow the STEEP method, which allows for identification of drivers of change (DOC) which are: Societal, Technological, Economic, Environmental and Political.

SOCIETAL drivers of change:

- Demographic renewal was of concern across all LLs, with most LLs fearing a future where decreasing and ageing populations continue to be a concern. In the more negative scenarios, a lack of human capital means that rural communities are unable to embrace the benefits of digitalisation. In more positive scenarios, new entrants (particularly young people) are attracted by strong digitalisation; their skills contribute to narrowing the digital divide.
- Cooperation and collaboration are seen as critical to positive digital futures. In the more positive scenarios, initiatives such as data cooperatives are envisaged; these collaborations enable trust to be increased at the local level.

TECHNOLOGICAL drivers of change:

- From smart water management and disease livestock control to preventative and responsive management of forest fires, the deployment of remote sensing and supporting digital platforms (for example livestock EID), promises to revolutionise the early warning capabilities across domains over the next 10 years. Negative scenarios depict untrusting or unskilled rural populations unable or unwilling to embrace such tools.
- Negative scenarios imagine the ongoing lack of decent broadband connectivity contributing to an increasing digital divide: without parity pressures, two-speed approaches continue to penalise rural regions. In more positive visions, local people act to ensure access to digitalisation, and connectivity enables better access to local services and wider markets for services and products.

ECONOMIC drivers of change:

- Digitalisation can potentially make energy transitions more efficient, but the ways in which rural stakeholders are able to generate and sell the necessary alternative energy supplies will depend upon the power structures and land ownership surrounding fuel sources.
- Digitalisation potentially offers future economic advantages such as reduced overheads (e.g. labour costs), through automation and efficiency savings. It can also open access to new markets through innovative supply chains and new retail models. For rural communities to see these benefits investments will be required, and farms, forestry and rural communities will need to fund future technological development. In positive scenarios, digitalisation will support rural livelihoods by enabling remote and flexible working, supporting a larger population to live and work in rural areas.

- Positive scenarios see digitalisation supporting shorter supply chains where customers demand more sustainably developed products. In negative scenarios, supply chains do not shorten due to digitalisation driving globalisation and reinforcing current market trends.

ENVIRONMENTAL drivers of change:

- In more positive scenarios, digitalisation supports the creation of biodiverse rich habitats. For example, the adoption of new technologies can reduce pressure on natural resources. In more negative scenarios, the uptake of digitalisation results in disadvantages to biodiversity – for example, digitalisation supports the ongoing move towards monocultures and resulting reduction in biodiversity.
- Digitalisation can lead to more sustainable rural futures. For example, digital tools can enable a more equitable stake amongst rural stakeholders to the use of certain resources. However, negative scenarios envisage a future in which progressing digitalisation promotes less sustainability, including the promotion of large-scale rural tourism which has negative environmental impacts and reduces availability of affordable local housing.
- Extreme weather events are seen to increase in the next 10 years across all LLs. Digitalisation can support our response to climate change - extreme weather events are more predictable and digital tools enable greater forecasting. However, future digital tools raise concerns, notably scepticism over their reliability, the preventative high cost of the tools to different land users and the lack of digital skills needed to utilise the tools effectively.

POLITICAL drivers of change:

- Rural communities can be empowered by digitalisation – for example, by giving people access to information or an active role in local decision-making. Digitalisation can disempower rural communities where digital inequalities are predicted to increase, resulting in an uneven balance of power between the more and less digitally skilled local actors.

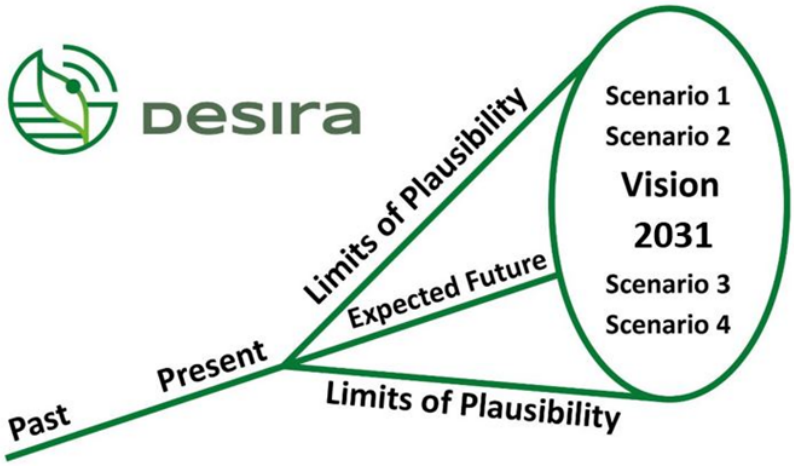
COVID-19:

- The Covid-19 pandemic saw many communities accelerate their acceptance of digital technologies as coping strategies to deal with social distancing, travel restrictions and an increase in their abilities to interact with friends and family, and colleagues online.
- The pandemic has facilitated rapid changes in health care including improved digital services.
- However, Covid-19 will also have a long-term financial impact which might hinder the development of digitalisation, particularly in remote rural regions.

2. Introduction

No one knows what will happen. The future is inherently uncertain. Contrastingly, we are able to look at both past events and the current situation with a greater degree of confidence. We can detect themes and construct patterns that act as guides, albeit imperfect ones, to the future. Scenario Planning is a methodology developed to consider a range of plausible outcomes, based on what we do know about the past and present. It harnesses human creativity and imagination, in order to make flexible plans now; plans that are robust enough and sufficiently flexible to deal with unpredictable developments.

Figure 1. DESIRA's Cone of Plausibility (after Bezold & Hancock, 1993)



As shown in Figure 1, the future can depart from expectations exponentially the farther ahead we attempt to foresee. In short, while tomorrow may be very much like today, a future day 100 years from now will almost certainly be completely different in all sorts of ways and imagining what they might be tests the limits of our creative faculties. This consideration affects the selection of a suitable time horizon for the scenario exercise: in DESIRA we have chosen a horizon of 10 years so our scenarios will relate to 2031.

There are many ways to conduct scenario planning. These can range from highly quantitative approaches to more qualitative, participatory approaches (Government Office for Science, 2017). One taxonomy differentiates between: *Predictive Scenarios* at the quantitative end of the scale, seeking to model what *will* happen; *Exploratory Scenarios* offering insights into what *may* happen; and *Normative Scenarios* setting out what *should* happen. It is worth noting however that all forms of scenario

planning are subject to normative influences and furthermore the three forms are not mutually exclusive (see also Cho, 2013).

DESIRA has adopted an 'exploratory' scenario development approach, which incorporates a strong qualitative focus. Kok et al. (2011) argue that *"…exploratory scenarios often strive for awareness raising, the stimulation of creative thinking, or gaining insight into the way social, economic, and environmental drivers influence each other"*. They are crafted to form plausible accounts of what the future might look like in consideration of known drivers of change having specific effects over time, with a strong qualitative element shaping the entire exercise. DESIRA developed exploratory scenarios through participatory exercises with stakeholders in each of the Living Labs. With a characteristic narrative element, exploratory, qualitative scenarios lend themselves well to stakeholder workshop settings.

Plausibility

The concept of plausibility is often preferred over that of probability by scenario planners. This distinction relates to the ambition to creatively explore future possibilities rather than make forecasts. It also connects with distinctions between more qualitative and more quantitative or probabilistic scenario planning. While both approaches have their merits, (for a full discussion see Ramirez & Selin, 2014), choosing plausible outcomes over probable outcomes allows greater flexibility to move beyond current assumptions. This distinction is important. We are not attempting to determine what the future *will* most likely be like. After all, what appears more probable today, or in other words, 'the expected future' often proves to be a poor guide to what will happen tomorrow. The concept of plausibility allows scenario planners to remain within the realm of realistic developments but to go beyond conventional thinking (see Fig. 1).

3. The STEEP approach and thematic analysis

3.1 The STEEP rationale

As explained in the methodology section (see Section 10), STEEP was deployed in order to generate a range of drivers of change (DOC) and is carried over below as an organising principle and should not be read as a taxonomy of discreet categories. Many DOC are crosscutting, for example being conceived variously as political and economic, therefore the order and placement needs to be appreciated within this context. See Figure 2 for a compendium of potential drivers shared with all LLs, to help guide their thinking. Given this caveat, the following thematic analysis has been arranged following the STEEP sequence. Some linkages have been made explicit to guide the reader, but such is the extent of the crosscutting that exhaustive signposting was considered to be overly distracting. Figure 2 shows the country LL names, country codes and the final scenario questions.

Figure 2: LL names, country codes and associated final scenario questions

Country	Code	Final scenario question	LL name
The Netherlands	NL	What does the urban farming community of Oosterwold look like in 2031, and what role could digital systems play?	Oosterwold, the Netherlands LL
Finland	FI	What will the bioeconomy in Central Ostrobothnia be like in 2031, given the progress of digitalisation, circular economy, energy transition and RDI?	Biovalley Finland LL
Germany	DE1	What will digital living (together) look like in Betzdorf-Gebhardshain in 2031?	Betzdorf-Gebhardshain, Rhineland-Palatinate (Germany): Between Digital Villages and Online Access Act – Digital Transformation in Rural Areas
Poland	PL	(What) will spatial planning in rural areas of Poland look like in the increasingly digitalised age of 2031?	Geodesign in Rural Poland
Latvia	LV	How to make use of the potential inherent in digital marketing for selling beef?	Living Lab Latvia
Germany	DE2	How can digitalisation contribute to sustainable fruit production in 2031?	Lake Constance Region LL
Austria	AT	What will timber tracking look like in 2031 in Europe?	Round Wood Traceability in Austria
Switzerland	CH	How will weeds be managed in Swiss organic vegetable farming in the increasingly digitalized age of 2031?	Weed management in Swiss organic vegetable growing
Greece	GR1	How can digital tools impact the management of water resources in relation to Trikala's farming, rural and urban needs in 2031?	Sustainable Water Management Living Lab
Greece	GR2	How to develop new digital services and functionalities for rural communities based on utilisation of existing agricultural infrastructure and tools. How can these services support economy and farmers' income in rural communities?	LL Digital Services for Rural and Farmer Communities

Croatia	HR	How digital technologies will improve the promotion and sale of local agricultural products in the tourism market by 2031.	DigiFarmTour - Digital solutions for connecting local agriculture and tourism in the Adriatic region of Croatia
Italy	IT1	How will digital tools transform Italy's wood-energy sector traceability by 2031?	Wood-energy traceability in Italy
Italy	IT2	How will the ordinary land management in mountain areas of the Reclamation Consortium "Toscana Nord" be managed in 2031? What role will digital technologies play in this process?	Toscana Nord LL
Spain	ES1	How can digitalisation contribute to reduce the damage caused by wildfires and to make more effective firefighting and degraded land restoration by 2030?	Forest Fires in Andalusia
Spain	ES2	How digitalisation and the 2030 agenda will change Maestrazgo and Gúdar-Javalambre by 2031?	Maestrazgo and Gúdar-Javalambre Digilab
France	FR1	What will French viticulture look like in 2031 in connection with the evolution of digital?	Inno'vin LL
France	FR2	What will be the contributions of digital technology to accompany the reduction of inputs in agriculture by 2031?	Agronov LL
Scotland	SCO	What will crofting communities be like in 2031 given future digitalisation?	Crofting in Coigach (Scotland)
Belgium	BE	What will be the impact of digitalisation and monitoring on ammonia emissions in 2031	Flemish Living Lab
Ireland	IE	How might a rural community enterprise centre support regional resilience in 2031, in the context of digitalisation and socio-ecological transitions?	Cultivate LL

3.2 Thematic analysis

Each Living Lab report was closely analysed and themes were developed that allow the individual drivers and assumptions to be clustered, compared and synthesised.

4. Societal (S) drivers of change

These thematic drivers of change and the related assumptions that were developed to create a range of contrasting scenarios in each Living Lab, primarily concern the cultural dimensions of our collective lives. They include values, demographic influences on communities, attitudes, lifestyles, and the media. For DESIRA Scenario Planners, a focus on digitalisation is explicit. Participants were requested to focus on societal drivers impacting on digitalisation or impacted by the changes digitalisation may bring.

4.1 Demographic renewal

Few rural contexts in Europe do not have concerns about future demographic composition. With the notable exception of the Netherlands, where a peri urban Living Lab had specific concerns about urbanisation (NL), all DESIRA Living Labs feared scenarios with declining populations, an ageing demographic (good examples being DE1 & FR1) and a consequential structural inability to embrace future digitalisation effectively due to a lack of human capital. Much of this shortfall was characterised around agricultural labour (CH, HR, GR2, ES2). A case in point was in the extensive livestock sector where a greater valuation in the activity and better returns for the product underpinned by digitalisation in the supply chain (including digital marketing (LV)) was seen as a potentially positive driver in arresting population decline (GR2). Similarly brighter futures were envisaged for family farms in other sectors:

> *Fruit production in family farms and farm succession has become more attractive for young people, which positively affects the preservation of small family farms. (a more optimistic vision in DE2)*

Here, a family farming future was rejuvenated within a digitalised rurality. New entrants to farming were similarly attracted to digitally enriched opportunities (GR1). The appeal to a younger generation potentially draws upon future 20-30 year olds previously mobilised by Climate Action as school children and seeking alternatives with Green-appeal (IE). In contrast, alternative land use options, for example holiday homes (including a negative impact from the AirBnB model (FI) and seasonal tourism (SCO) and other forms of unregulated or unsympathetic development including prohibitive transportation costs and associated fuel poverty (IE) would reinforce existing negative trends and were seen as potentially disenfranchising for local communities (see also Section 8). Robotics, automation, and labour saving, while generally seen as supportive of vibrant rural populations, were not viewed as without risk. A high use of technology in agriculture, as history has shown, sits hand in hand with a large decrease in population in negative scenarios (IT2).

Beyond agricultural labour, a general rural community capacity (SCO, PL) was envisaged in some of the more optimistic scenarios, including distributed manufacturing (IE) enabling young people to

continue living in rural communities or encouraged to inwardly migrate through the virtualisation of work (SCO). This repeated theme around rural mobilities including remote working was often expressed as a hoped-for paradigm shift (FI, ES2). Given longstanding declines in rural populations throughout Europe many participants found it easier to conceive of a continuation of rural depletion considering this to be both plausible and a constraint upon positive digitalisation (SCO, HR, CH). In polar opposition, a design feature of the scenario exercise we implemented, another plausible opportunity was positive digitalisation enhancing demographic renewal (SCO, PL, ES1, ES2, GR2). This included a partnership approach to land use with farmers and local communities with greater empowerment in decision making through digital fora (IT2, SCO).

The idea that digitalisation can increase the attractiveness of a rural locality (GR2, SCO) by supporting work, reducing isolation, increasing opportunities, and offering parity with urban areas in terms of data service provision, was a component of many of the more positive future visions that stakeholders shared. This idea intersects with positive aspirations around diversity (see Section 4.5) with inward migration connected to open, welcoming, informed, and modern rural communities and disconnected to closed, inward-looking, conservative societies (GR2, SCO). Mountainous areas were highlighted (IT2) as critically in need of improved connectivity to stave off depopulation. It was also noted that employment opportunities might take a turn for the worse or continue to decline (IT1), reinforcing rural depletion and that poor connectivity drives further outward migration (DE1, IT2) particularly for young people.

4.2 Digital Literacy

Who will operate the digitalised future? Many LLs considered different trajectories that explored positive and negative outcomes from a highly skilled, competent rural workforce spearheading a digital transformation of practices, to a rurality lacking the requisite digital literacy and ill equipped to take on the challenge (BE, SCO, LV, GR2, ES1, PL). Despite the potential for digital technologies to be more widely available and usage increased (DE2), providing many opportunities for rural communities (IE) even in the brighter futures, it was acknowledged that everyone would not acquire sophisticated technological acumen. However, in the pessimistic futures a complete lack of digital skills and rejection of digital tools (FR2) and thus the training and upskilling of the workforce to become more digital literate with digital technologies is imperative (e.g. for agriculture FR1, IT2) and is seen as critical to a successful digital future. Other LLs felt that those lacking digital skills ought still to have a viable future and the wider farming community could play a part in supporting them perhaps through the championing of 'digital-natives' (BE, DE2) or alternatively, they must compensate through non digital skills.

Digital literacy was felt to be uneven (NL); a digital literacy divide could emerge between those with high and low digital skills, with FR1 arguing such a divide could create a *"two-speed viticulture".* Currently digital literacy divides exist whereby more ageing populations have reduced digital literacy and acceptance of technology both in general (DE1, GR2) and in the workforce (ES1) it is also felt that the digital gap between older and newer residents may also grow in the short-term (DE1, DE2, FI GR1). It will be important to minimise digital literacy divides so that the LLs do not fall behind urban areas, for example digital skills may need to be taught in schools (DE1) and young people may be the aid in promoting increased digital literacy building confidence and skills (SCO, FI). Other LLs (FR2) identified

that it will be important that training that promotes digital skills should be available to all to enable them to embrace the full benefits digitalisation can bring to rural communities (FR2, GR1). One way in which digital literacy could be decreased is by "digital-natives" in the region acting as a sort of champion and to do outreach work/teaching to others in the community (DE2) and by using digital tools more frequently, which could help to build knowledge and develop confidence (DE2). In Italy (IT2) it was suggested that low digital literacy and skills justify the need for fully autonomous technologies rather than assuming collaboration and integration with humans and technology, and FI found that automation in farming is seen positively and as a means to remain profitable.

Many more positive futures envisaged a growing younger demographic boosting the viability and sustainability of rural communities motivated to become involved in rural livelihoods including farming, by having the necessary digital skills to make it profitable (GR2). Covid-19 has also promoted increased digital education and literacy (e.g. through new ways of delivering healthcare - ES2). The wider use of digital tools in both farming and across the wider rural community helps to build confidence and promote the ongoing use and interest in new digital innovations and tools (IE, FI).

Standard services expect time commitment and access to travel to make appointments and visit official offices. Although people see the advantages of using digital services for convenience (ES1), speed of accessing services on-line, reducing travel and the need to visit offices (especially a problem during covid-19 - see Section 9) they also see the disadvantages, including the lack of face-to-face contact, not being able to speak to a point of contact to explain problems, and the subsequent feelings of isolation that can come from this. In some countries (DE1, SCO) a hybrid way of accessing medical services, initiated during Covid, was welcomed, whereby people were able to make appointments on-line and were given some resources (access to live chat, phone calls) for triage assessment but were then able to visit a GP for final diagnosis. This was not the case in all countries - some resisted the hybrid health care opportunities (ES2) preferring the ability to embrace a more personal touch. Some flexibility is accepted in remote rural communities where people see the advantage of digital services and have welcomed the ability to access services like those provided by banks through updated banking apps (SCO) reducing time and travel costs.

Flexible working options (working from home) have given people the choice of relocating from urban to rural locations (FI). There is also the possibility of reducing working hours and all year working (FI). In some regions, communities debate whether to regulate who should move in depending on their commitment to the community's values and ideas on participation (NL).

4.3 Trust

Although people realise that digital services can bring benefits they are often fearful that their data will be misused. They balance the advantages gained through trusting people with their digital data with the disadvantages that allowing access might bring, for example potentially losing their capability to control access to their personal data (DE1) with stories of stolen identities (SCO). Some citizens have a mistrust of public/local authorities in general (IT1). Others hope that embracing digitalised and participatory services might increase trust associated with planning (PI).

In the agriculture domain a general mistrust of digital tools for agriculture processes (GR2) is countered by the advantages gained by better transparency on production and environmental impacts

(FR1,FR2) and traceability to allow provenance to be recognised (HR). The reliability of on-farm tech has helped increase trust of digital technology in some areas (DE2) although not for all technologies, for example drones have low acceptance due their limitation related to weather and ability to identify specific events (IT2).

4.4 Cooperation and collaboration

The social aspects of co-operation and communication were seen as necessary between different stakeholders in the most positive scenarios being developed (AT, IT1). Incidences where co-operation and communication were enhanced were also likely to lead to increased trust (NL). In the more positive plausible scenarios, positive cooperation and communication was seen to be able to amplify voices (e.g. political voices in SCO). In PL, access to new methods in spatial planning through community negotiation was felt to be the starting point to making the rural environment more multifunctional and diversified. In GR2 improved collaboration of farmers through a strong farmers union was seen as being positive to negotiating with technology providers. Whilst in FR2 cooperatives were seen to exist in the better not best scenario to aid in data sharing and in FR1:

"Winegrowers have also organized themselves and created data cooperatives in the middle of the 2020's. Those data cooperatives oversee collecting and valorising data for all their members. The data cooperatives also ensure the sovereignty of the data." FR1

As well as positive forms of communication and cooperation leading to increased digital bargaining opportunities, it could also lead to other positive scenarios such as the opportunity to share digital tools thus reducing investment costs (DE2). Enhanced communication and cooperation can lead to ventures such as the FabLab leading to diverse (digital) opportunities: "*the FabLab is used to produce and repair things for the Ecovillage, to create artworks for local festivals held on Ecovillage land, and to make products and packaging for sale through the Open Food Hub. Frequent 'repair cafe' events take place, during which technicians dedicate their time to fixing any broken items that individuals bring in." (IE)*

In some of the more positive plausible future scenarios, cooperation between local actors is considered critical for local management in the future and responding to extreme weather events etc (e.g. IT2 and ES1) and also for food production (NL). Collaboration and co-operation were also seen as important between local water management agencies and regional authorities (GR1).

4.5 Diversity

Currently, there are general pushes to a more diverse society, and in many cases (SCO,) positive plausible scenarios show increased digitalisation leading to a more diverse society (e.g. LGBTQ+ may be more accepted and promoted in a more digitally progressive community -SCO), and in PL digitised spatial planning was felt to promote more diverse voices to be included in the future participating and accessing spatial planning, thus increasing diversity. In the predominantly negative futures where rural demographic challenges remain diversity is restricted because only those currently living in the area participate (GR1). Diversity may also increase tension between those who have lived in a community for a long time and younger incomers relating to the speed of (digital) change and the implementation

of new ideas of the community (IE). There was some division about whether diversity of immigrants meant a more positive or negative future as in FI diversity was seen to signify a weakness of the local economy when there is reliance from immigrants to fulfil certain jobs, however in NL an ambassador is recruited in the optimistic scenario, and *"This new generation of residents became more diverse in terms of ethnic and cultural background, age, and experience with agriculture. One task of the ambassador was to welcome people from all backgrounds to Oosterwold and get them up to speed in both the community and practices around urban agriculture."*. Even the foods grown become more diverse thanks to the diverse cultural background of residents.

5. Technological (T) drivers of change

DESIRA has a special focus on technological factors in line with our aim to a respond to the challenges and opportunities of digitalisation in rural areas. Factors typically investigated in this part of a STEEP analysis include automation, technological shifts, the rate of change, innovation, and how these various factors may combine to shape the future. For DESIRA, all Living labs were encouraged to consider more than one technology driver.

5.1 Data privacy

The concept of data privacy encompassed notions around data sovereignty and data ownership. A full range of concerns emerged echoing popular discourse. Data privacy was variously considered a political driver (BE) to be tackled through the rule of law but was more generally seen as a technological consideration (FI, DE1, DE2, LV, HR, IT1, ES1, FR1, FR2, SCO). Participants feared an absence of digital privacy in a brave new world in which big corporations increasingly erode individual's data ownership and control (FI). Due to a lack of digital literacy farmers didn't realise the need to protect their data, 20 years later in some countries (e.g. FR1) it is felt they have missed the opportunity as large companies collect data from digital technologies and use the information to manipulate markets. In more positive futures, however data sharing is seen as the norm and encourages interoperability (FR2, GR1). Improved regulations on sharing would help acceptance (DE2) although there are discussions on who is responsible to implement these (DE2) - legal clarity is needed (CH) , in conjunction with National databases and online protocols (ES1). This would help citizens to trust the sharing of personal data and the acceptance of Open Access agreements (OAA; DE1).

Political dimensions and potential resolution through regulation and oversight again demonstrate the transversality of Drivers of Change. In West Flanders (BE), science led innovation was projected as a potential solution whereby farmers could share and access data equitably through neutral hubs.

In the forestry domain multi source data allows traceability of wood, reducing illegal felling and trading in non-traceable wood commodities (AT, IT1).

5.2 Digital tools and technologies

Central to DESIRA are the technologies that are already and will continue to shape rural society, including agriculture and forestry in the coming decade. The LLs were replete with examples of

potentially game changing developments. From cargo drones that may emerge to support local produce along short supply chains (HR) to weeding robots overcoming labour shortages in the organic vegetable sector (CH), digitalisation can reshape many existing practices. Many of the technologies DESIRA details have specifics that allow limited comparison to other LLs albeit they will be replicated elsewhere in Europe, and for this layer of information the reader is directed to the Appendices for a fuller account of these individual future developments. This synthesis is largely confined to a higher level comparison of digitalisation features and future impacts that may be relevant across LLs.

Real-time or effectively real-time information platforms were discussed in terms of their potentially strategic benefits. From smart water management (GR1) to disease livestock control (LV) to preventative and responsive management of forest fires (ES1), the deployment of remote sensing and supporting digital platforms (for example livestock EID), promises to revolutionise the early warning capabilities across domains. Wildfires and forest fires are exacerbated by climate change, and increased extreme weather events, a state of affairs unlikely to be addressed by 2031, and better forecasting and incidence alerting was envisaged to offer significant mitigation in more optimistic scenarios. It was said that 'geolocation saves lives' (ES1). Similarly, access to new GIS technologies and more sophisticated processing of geospatial data will potentially lead to the administrative units dedicated to the mapping and appraisal of water resources (smart water), ensuring that regional water needs can be covered and water is handled in a sustainable manner (GR1). Remote sensing in particular is an area through which digitalisation can improve decision support (BE, ES1). A darker side was imagined, particularly in agriculture, where the emergence of a Panopticon accompanies a large decrease in local population:

"… the eye of technology replaces the knowledge and experience of those who live, work and experience the land." (IT2)

Beyond dystopian surveillance, worse not worst scenarios posited the challenges around interoperability, failure to share data effectively, and slow roll-out of fast broadband to address rural needs. A general digital divide between urban and rural, reinforced by current experience, coloured many more negative scenarios. Without parity pressures, two-speed approaches will remain that effectively penalise rural areas (PL). With equivalence of provision, particularly broadband speeds, more local farmers will start to experiment with the adoption of digital tools leading to new opportunities and value chains, technology providers will offer new possibilities for upscaling applications to a wider geographical range and making tools adapted to rural contexts (GR2, FI, PL).

Enhanced traceability is another aspiration found across Living Labs. Harnessing digitalisation (including blockchain) to improve and extend the traceability of products, from wood biomass (IT1, AT) to meat (LV) was viewed as a potential digital game changer in terms of both controlling and regulating trade, and through building trust and confidence with consumers.

The farming future was animated with robotics deployed at the field scale, weeding (CH) and generally replacing agricultural labour (FR2, DE2). Drones can be seen delivering goods along short supply chains (HR) and conducting other autonomous or semi-autonomous tasks. Drone delivery is just the front-end of a new retail experience with virtual reality on-line shopping promoting local products (EI). Infrastructure, such as Switzerland's Agroscope Smart Farming Institute (CH), spring-up to drive farming forward. Easy to use apps are in the hands of farmers (DE2) who practice precision farming (DE2, FI, NL).

"They provide technological means to reduce inputs and are adapted to all types of production and protection products. They free up human time for complex operations." (FR2)

Local communities are partners in the technological renaissance envisaged for positive scenarios. Digital healthcare (DE1, ES2), on-line banking (SCO) and platforms supporting rural tourism (FI) flourish. Distributed manufacturing shrinks distances and supports local opportunities (IE). Where optimism gives way to pessimism, there is a lack of understanding of tech, and a reticence to adopt by many actors. In the absence of robotic success, whether due to neo-Luddism or the lack of digital skills, agricultural industries fail to compete effectively. In one worst case scenario, there is a complete lack of digital skills and rejection of digital tools (FR2). Other fears surround the loss of appropriate in-person contact and a descent into an inhuman metaverse. Patients cannot see real nurses or doctors and many taken-for-granted contacts are reduced or withdrawn.

In general, the availability of tech was appreciated as a resource likely to become more affordable and more diffused (CH). Something akin to Moore's law appears likely to continue to drive down cost and reduce barriers to entry moving towards 2031. This is not necessarily a positive trajectory as both the desirable and undesirable effects may be spurred through the relentless march of digitalisation.

5.3 Innovation

Innovation was associated with the more positive plausible scenarios particularly around taking advantage of new digital opportunities or existing technologies in new ways (for example the use of the What three words App to identify rural positions for food deliveries (SCO)). It was seen to happen at community level and professional levels. For example, highly innovative companies were seen as necessary to increase employment in some ways (DE1). Innovation was also seen to aid diversification in businesses (GR2). In agricultural it was seen as a way to increase skills, and share knowledge and skills with others through digital platforms (FR2).

Innovation in technological development was felt to be able to aid tackling environmental hazards such as forest fires (ES1) through the employment of digital tools such as remote sending, RTI flows and modelling based on artificial intelligence to predict impact and decrease response times (ES1).

However in the more negative plausible scenarios innovation through diversification could increase business risks (GR2). Innovation may also be promoted more effectively in some places than others by legislation in some worst case scenarios (FR2): *"Strengthening of the AOC's, which reinforces the link to the territory and the environment and prohibits many innovations. The international definition of wine is becoming stricter. The terroir viticulture is now the only one that remains"* - FR1. In IT2 however in the better not best case, policies would support the creation of an innovation ecosystem and facilitate the integration of innovation and digitalisation policies. Crises and possible more negative scenarios may also lead to innovation and creativity in response in some areas, for example to global supply chain crisis, or hinder it through unavailability of goods to solve issues innovatively (IE).

6. Economic (E) drivers of change

Factors potentially shaping the future rural economy include the cost of goods, both retail prices for goods that are produced on farms and in forests, but also the cost of capital investment required in digital transitions. DESIRA scenario planners were encouraged to consider subsidies, consumer demand, consumer prices, and the underlying costs of technology. Again, these drivers were intended to be set against digitalisation towards 2031.

6.1 Energy transitions

An energy transition requires a deep structural change from a reliance on fossil fuels, natural gas and coal to renewable energy sources such as wind and solar and other alternative sources. Whilst an energy transition implies a global structural change, the LLs in their discussion of energy transitions reflected local and regional level changes requiring the cooperation of and drive from local government agencies (SCO, GR1, FI). A global energy crisis and resulting fuel poverty was still imagined in the positive future scenario (IE) and while this brought hardship for many it also served as an opportunity to drive localised solutions and find alternative sources of energy (SCO, GR1, FI, IE, IT1). In agreement, the French LLs (FR1, FR2) stated; *"a more environmentally aware sector embraces alternative energy sources in the more climate-friendly scenario."* A growing rural population interested in the environment and climate impact can not only drive the popularity of alternative energy sources but also apply significant pressure for the sustainable use and reduction in illegal trade of certain forest products (AV).

One common suggestion shared by both the Scottish (SCO) and Trikala, Northern Greece (GR1) LLs was for local authorities to convert wastewater into an energy source and also provide nutrients to the agricultural sector (potentially reducing reliance on added nutrients sourced from elsewhere). The Finnish LL in their better not best scenario saw a particular benefit to rural areas from selling electricity, biogas or hydrogen to urban centres and industrial plants and the "a*dvancing energy transition through digital technologies is a great opportunity to increase the sustainability of energy system in Central Ostrobothnia" (FI).* Digitalisation was able to make the energy transition overall more efficient. The ways in which rural stakeholders are able to generate and sell the necessary alternative energy supplies will depend upon the power structures and land ownership surrounding the fuel sources. Necessary infrastructure will also require significant investment. In the Irish LL, there was an apparent 'regret' over prior inaction to replace or repair faulty solar panels before the components became difficult to source in a future contending with a global demand and supply issue. Yet certain areas or 'pocket neighbourhoods' are able to keep a steady supply of locally generated electricity thanks to the effectiveness of 'micro-grids' and the installation of biodiesel generators (IE).

6.2 Fair prices and future investment arrangements

Many Living Labs focussed their attention on the likely effects of digitalisation on the prices that they can anticipate from their produce under different scenarios. Concerns incorporated some thinking about future subsidy and investment arrangements. A digital landscape offers opportunities to reduce overheads, notably labour costs, through automation and efficiency savings. It also potentially opens-

up new markets through changed supply chains and new retail models. To seize benefits however investments will be required, and farms, forestry and rural communities will need to finance future technological development.

Opportunities were identified on a number of fronts. The possibility of improving produce and commanding higher prices was discussed by several Living Labs (LV, NL, BE, IE). The idea that customers may be willing to pay higher prices for products that have trusted provenance (HR, LV, SCO), or that enhanced traceability can better protect forestry (IT1, AT) and farming goods from illegal and unfair competition, carried attractive prospects for stakeholders. Linked to new digital capabilities to guarantee provenance would be new opportunities in sustainable markets including housing and construction (AT). New European demand for traceable items (IT1) may boost the production of roundwood (AT), sheep skins (SCO) and food products, both utilising shortened supply chains. Regional branding and marketing might be further developed and promoted through digital platforms (SCO).

"The agro-ecological label finds its place among the recognitions and brands of quality. It makes sense for the consumer, who is ready to pay more for a premium and environmentally friendly product." (FR2)

Consumer willingness to pay more was also problematised in negative scenarios (FR1, IT2). One uncertainty rests with the cost of implementing the smart tools required for transitioning (FI, GR2). The example of connectivity in very remote areas (IT2), and more generally of costs falling directly on farmers and foresters (FI), injected negative sentiments into Scenario Planning sessions. A central issue foreseen is that many smaller operators, for example family run farms, do not have the capacity to invest for the long term and require more immediate return on investment to re-tool or up-skill. One example was virtual fencing for sheep ranching that may continue to be prohibitively expensive (SCO). The lack of affordable housing for locals was another current constraint projected to continue in more negative scenarios (NL, SCO), including the digitalisation of tourism, creating demand through an AirBnB model of holiday accommodation pricing locals, particularly youngsters, out of the housing market (SCO, NL). These negative considerations turned the discussion towards subsidies and other models to underpin a technological transition.

More structural investment, often at the European scale, was envisaged (HR). A Rural Development Program and new CAP strategic plan could result in financing for tailored solutions to meet the needs of local communities (GR1). This might include public investment to support rural digital literacy (IT1) and to develop e-Government platforms (IT2). A Green Dividend derived from programs including carbon sequestration giving value to environmental assets that currently don't have one (ES1) might provide structural funding to develop smart management approaches. Energy transitions might further boost rural incomes if models that reward community wind power are adopted, although trade-offs are difficult to predict (FI).

6.3 Changing societal demands and changing consumption patterns

Stakeholders considered the future of rural communities, agriculture, and forestry towards 2031 through the lens of demand and consumption. Changes in values, particularly around consumption, clearly present both opportunities and threats, and future uncertainty framed a wide-ranging discussion.

A drive towards self-sustainability and supply of local produce through short supply chains (NL), predicated upon changing public perspectives about planetary boundaries and sustainability, was eagerly anticipated (IE). In other words, a reorientation of food systems from globalised markets to local, seasonal and sustainable short supply chains was prevalent in many better not best- and best-case scenarios (IE, NL, SCO, LV). The ability to respond to new demand was strongly associated to product traceability and provenance which in turn were areas for digitalisation to play a major role. Domains included wood products from forestry (AT) and food from agriculture (NL, IE, SCO, LV). Local food hubs utilising online platforms and local businesses directly marketing or using digital services in inventive ways already exist within our sample and positive projections saw growth and benefits to rural areas. In the food sector such developments were said to potentially encourage diversification of local produce (NL) which in turn was foreseen as stimulating demand (NL).

Different assumptions considered the extent to which consumers will embrace environmentally friendly products and be prepared to pay more for them (see Section 6.2). While digital technology is considered instrumental for transparency of provenance of (HR, AT, FR2), setting standards and enabling trust, the degree of appetite for change was questioned through our structured approach. An engaged public, in the more optimistic scenarios, had a strong appetite for authentic touristic experiences (IT2, HR), for sustainable food (IE, NL, LV) from ethical businesses maintaining high animal welfare (LV, IE) and other strongly shared values. In one Living Lab (IE), an 'Open Food Network Ireland' constitutes a digital farmers market:

> *The platform now includes a virtual element, so customers are able to visit the producers online to see exactly where their food comes from, and to judge for themselves whether products meet their ethical standards (the public is now much more concerned about sustainability and food origins and holding businesses accountable). (IE)*

However, one positive scenario (FR1) saw a downside to shorter supply chains. For wine, one scenario envisaged only the most famous, prestige wines being exported and declining access to international markets for lesser brands due to equivalent preferences for short supply chains in distant markets. The caveat to optimism surrounding short supply chains being that many high value global supply chains sustain rural enterprises and change will create losers amongst those currently enjoying export markets. Another exemplar was in GR2 where a declining market for tobacco is already leading to agricultural diversification that does not enjoy the old certainties. Where the region used to have a collective ability to grow and market tobacco with an established, efficient infrastructure, it now suffers from a loss of identity with products such as leeks not replicating the niche.

More negative scenarios assumed that supply chains would not necessarily shorten. In one *worse not worst* scenario, eco-friendly farming practices reduce because it has not been possible to promote these practices effectively to consumers (FR2). Another more pessimistic outlook detected a move to more online buying threatening the viability of small shops, farms, and rural businesses (IT2).

6.4 Local livelihoods

The way in which people work may vastly change in the future particularly one in which digitalisation has increased the opportunity for people to live remotely from their physical workplace as well as increasing the resilience of both individuals and communities (FI) by allowing them to take advantages

of the local economy and food chains (NL). There may also be less disparity between rural and urban incomes (FI). For others, digitalisation might mean that their job is redundant or partly replaced by technology. In the more positive scenarios, it was felt that digitalisation might create opportunities for rural communities (SCO) or affect rural infrastructure and the availability of the labour force (ES2) e.g. more widely accessible university training in rural communities (SCO). However in the more negative scenarios it was felt that more people might move to live and work in rural communities without local knowledge which could negatively affect the region's sustainability through inappropriate land management (Including in forest areas, ES2).

For farming, it was felt digitalisation may increase farmers income (IT2, GR2). FI specified that this could be achieved through diversification and income coming from different sources such as tourism and forestry. Other ways in which the sector might be affected in the more positive scenarios included: attracting new individuals to work in rural regions (GR2); less reliance on short-term seasonal workers (e.g. for harversting DE2); and less on-field work (DE2). In IT2, the better not best scenario imagines an initiative in which involving farmers in local water management is rewarded with income: *"The Reclamation Consortium "Toscana Nord" verifies the need for the intervention and, if possible, assigns it to the farmer responsible for the area (who often is the same one who made the alert), with the corresponding* ***payment for the maintenance work****. This represents an important income integration for farmers in remote areas and it is also an interesting* ***incentive for participating in E-governance*** *initiatives and providing data on the status of the environment with a citizen science approach."*

Other sectors that felt that rural livelihoods could be affected by digitalisation in the future included forestry (ES2), circular economy including water management (e.g. 'hubs' able to extend outreach from water management to other sectors GR1). It was also noted that many small businesses have sprung up: growing, harvesting, preparing, preserving and selling local produce, and using online methods is now the norm for creative industries. (IE)

7. Environmental and ecological (E) drivers of change

Sustainability, biodiversity, and climate change are all fundamental factors that need to be taken into account to understand the unfolding future. The physical constraints that the climate emergency is imposing on food production, forestry, and the rural environment more generally, not least, extreme weather events, will continue to impact the future beyond 2031. In addition, mitigating those effects through regulatory and policy instruments in the context of changing values directly related to the environment, will result in pro-environmental behaviours that must be factored into our strategic foresight. Living Labs were asked to consider these drivers within the context of digitalisation in rural areas.

7.1 Biodiversity

The biodiversity of the planet has been a concern for many years with many critically endangered species present on the red threatened endangered species list. Positive action would see a brighter future with creation of biodiverse rich habitats enhanced by the uptake of digital technologies. (AT) Adoption of new technologies reduce pressure on natural resources (FR2), use of digital wood traceability will encourage illegal practices (AT, IT1), whilst water levels can be ratified and maintained

with new tools (GR1). Although some countries see the uptake as unhelpful resulting in the depletion of soils leading to a reduction in biodiversity (FR2). The use of monocultures continues to decrease biodiversity. Measures taken to enable the use of some new technologies have disastrous effects on biodiversity e.g. increased fencing or land consolidation to make smaller plots , decreases movement of wildlife (DE2, FI)

7.2 Sustainability

Digitalisation can help the building of a sustainable future. Majority of LLs in the more positive scenarios envisaged a public concerned with wider sustainability issues across different sectors including the environment (IT2, FR1), agriculture (FR2, FI), economy and tourism sector (SCO, GR1, DE2) and in the building of community resilience (IE). A demand from consumers for more environmentally sustainable products (FR1), along with eco labelling of earth friendly products (HR) has brought about changes in some sectors. However, some producers remain unconvinced of the need for specific certification (organic, environmentally friendly) adding unnecessary costs to the business (FR2). Whilst consumers and wider society are looking for environmentally friendly produce there is a fear that legislation is insufficient or unattainable for many producers (FR1).

An overall growing environmental awareness is seen (IT2) although sometimes this is driven by top-down activities or mixed attitudes which can lead to positive activities on different levels and scales (PL). An increased demand for carbon neutral produce and services stimulate the diffusion of clean energies and traced (legally imported) biomasses for energy purposes (IT1). Affordable housing (SCO) and improved energetic performances of buildings, domestic boilers and industrial plants increases demand (IT1). Although efficient energy is sought, some areas see the placing of wind turbines to increase the clean energy supply as detrimental to the environment and therefore unsustainable (ES2). Digital tools however can be utilised to plan in the effective siting of windmills to maximise returns (ES2). A scarcity of land to build houses however is a block to this future (NL). Similarly, an increase in tourists due to a prolonged tourism season (HR, see also 'Climate Impact') is a concern for communities to have sufficient housing for residents as opposed to visitors (SCO). An increase in 'agri-tourists' could lead to an overall ineffectiveness of some digital tools that require parts of the landscape to be closed off (DE2) and therefore building tension amongst different land-users.

Finally, many LLs saw changes that were to benefit the wider rural and regional community. This was envisaged through moves to a circular economy (GR1) tied into pursuing local alternatives to meet global energy crises' and building community resilience (IE). Digital tools to enable effective water monitoring, benefits the entire region as water management is necessary to the sustainability of the region (GR1). Digital tools enable a more equitable stake amongst different rural stakeholders (FR2) to the use of certain resources. Agriculture diversifies to become 'multi-functional agriculture' (FI) and other income streams are available, lessening risks associated with specific monocultures.

7.3 Climate impact

Climate change and the impact from this was a concern to most LLs. In particular, the potential for digitalisation to mitigate the impacts from an increase in extreme weather events focused attention

(DE1, DE2, IT1, FR2). Forest fires, floods and droughts were deemed to largely increase in frequency and impact across both rural and urban areas in future scenarios, as well as threats from zoonoses (LV) due to the changing climate. The digital response however, notably brought winners and losers across the rural, agricultural and forestry domains. Extreme weather events are more predictable (FR2) and digital tools enable greater forecasting (ES2) which can aid in the preparation of adequate responses (DE2, FR2). However, the tools developed raise concerns, notably scepticism over their reliability (FR2), the preventative high cost of the tools to different land users (FR2) and the lack of digital skills needed to utilise the tools effectively (IT2). In the worst-case scenarios, the overall threat and concern from increasing extreme weather events affects the growing season for many farmers to the extent that they leave the sector altogether (FR1), and agricultural land abandonment with unregulated forestry can also increase the fire risks posed (ES1). However, the changing climate enables a longer tourist season (HR) and potentially provides an alternative income to rural stakeholders.

Given the increased frequency of these weather events as well as the indiscriminate nature of the effects from extreme weather there is an increase in public interest to find solutions (IE, ES1, DE1, IT1). A "general awareness" (ES1) applies pressure to create enhanced cooperation and coordination amongst different land users to mitigate damages from extreme weather (ES1, IT2). A mobilised public including former School Strikes for Climate movement activists (IE), and a demographic renewal in rural areas (see 6.1), leads to a burgeoning creativity to develop local solutions to combat the worst of climate change effects (IE, IT2, DE2, ES1). Digital tools include waste receptors, sensors to record water quality (GR1), high-tech cultivation measures (DE2) and enhanced monitoring tools (IT2). Other non-digital measures include a reduction in "frivolous" travel (IE) and increased domestic holidays (FI) that lead to a conserve of energy that can be directed into alternative uses and important savings on carbon emissions (FI). Importantly: "*The increasing extreme climatic events ask for improved land and water monitoring system in remote and mountain areas and an improved ordinary land management strategy, to reduce the potential hydrogeological risk." (IT2).* In this scenario, a holistic land management strategy incorporates both human capital and new digital tools.

8. Political or policy (P) drivers of change

A political lens allowed participants to consider how power dynamics may reshape European rurality towards 2031. In the domains of European agriculture and forestry, the European scale has had a profound effect on production and markets over the past fifty years or more and it was expected that DESIRA Scenario Planners would explore the role of the CAP and of subsidies on future developments. As with the preceding driver domains, DESIRA Scenario Planners were asked to retain a focus on digitalisation. The impact of digitalisation on the political landscapes across Europe intrigued many participants. A generalised fear that power may shift away from local stakeholders to become more consolidated in the hands of big corporate players within the metaverse was evident in several LLs (SCO). Power can be furthered by digitalisation by giving people access to information or a say in things they might not have had before, for example in GR1, increased public awareness and participation in water management decisions could apply pressure to local authorities to ensure sufficient water standards (GR1). In other examples, digitalisation was also felt to reduce disparities between urban and rural areas (FI). Power can also be hindered when digital inequalities are predicted to increase, for example in terms of uneven balance of power being observed between the more and less digitally

savvy viticulturalists (farm owners - FR1). Continuing with the digital divide and digital literacies theme, a shift in power between different scales of enterprise (farms etc.) was considered in the worse not worst case in IT2, where it was felt tech companies have the most power due to the high rise in tech usage.

Power was also mentioned as occurring at difference scales. At the European or larger scale, politicians and private companies may push the positive experiences of digitalisation (DE2). Other examples included: the influence of green political European parties in pushing a sustainable and green agenda (AT) – specifically in this Living Lab on the role of forestry in international climate pledges including reforestation for carbon sequestration; more public investment in Spanish rural areas and more responsibility by public administration to establish data protocols and data interoperability mechanisms (ES1); post-communist context to Croatia where a more narrowly focussed EU was envisaged with political instability as a potential dystopia (HR). At the local municipality or authority level – local administration responsibilities and privatisation was mentioned for example through the implementation of an online act – OAA in DE1. The role of the state in implementing acts to digitalise data to increase accessibility was also considered in relation to spatial planning in PL. Digital transition in spatial planning in Poland has transformed the political and governance system (started in 1990s) which introduced a decentralised model of spatial planning including participatory planning and increased digital transition in terms of spatial planning processes and data (in the more positive scenario). Formalised through Spatial Planning Acts (2003) and in 2020 the act was revised to make digitalisation of planning documents necessary which continues to increase sustainability and local democracy (PL). In NL, the two scenarios reflect tensions around how much the community will be regulated externally or be allowed to self-organise in the future. In IE, a new co-operative governance model in place was led by older pioneers but they find their ideas and experience are often sidelined by younger generations keen to make their own mistakes and take new risks.

Power was also mentioned in terms of local power in some scenarios such as lobbying against clean energy slowing the uptake of legal wood sources (IT1) tobacco growers in Greece (GR

), landownership in Scotland (SCO), an uneven balance of power is seen between the more and less digitally savvy farmers (FR2), in FI fragmentation of forest land ownership in streamlined. In NL, in the more positive scenario, self-organisation persists in the future, and very quickly, *''By 2022, there were weekly meetings where residents visited each other and told the community about their plans and obstacles".*

9. Covid-19

The start of the Covid pandemic saw many communities accelerate their acceptance of digital technologies as coping strategies to deal with social distancing, travel restrictions and increase their ability to interact with friends and families as well as a renewed way of working. Some now fear that this boost to digitalisation might be lost and the advantage won through dire circumstances might not be embraced as the new 'norm'. Increased digitalisation is not necessarily all good and needs to be

considered as a solution for social connections when face to face is not possible, there will be divides between those who want to start meeting in person to socialise versus those who wish to continue to engage digitally.

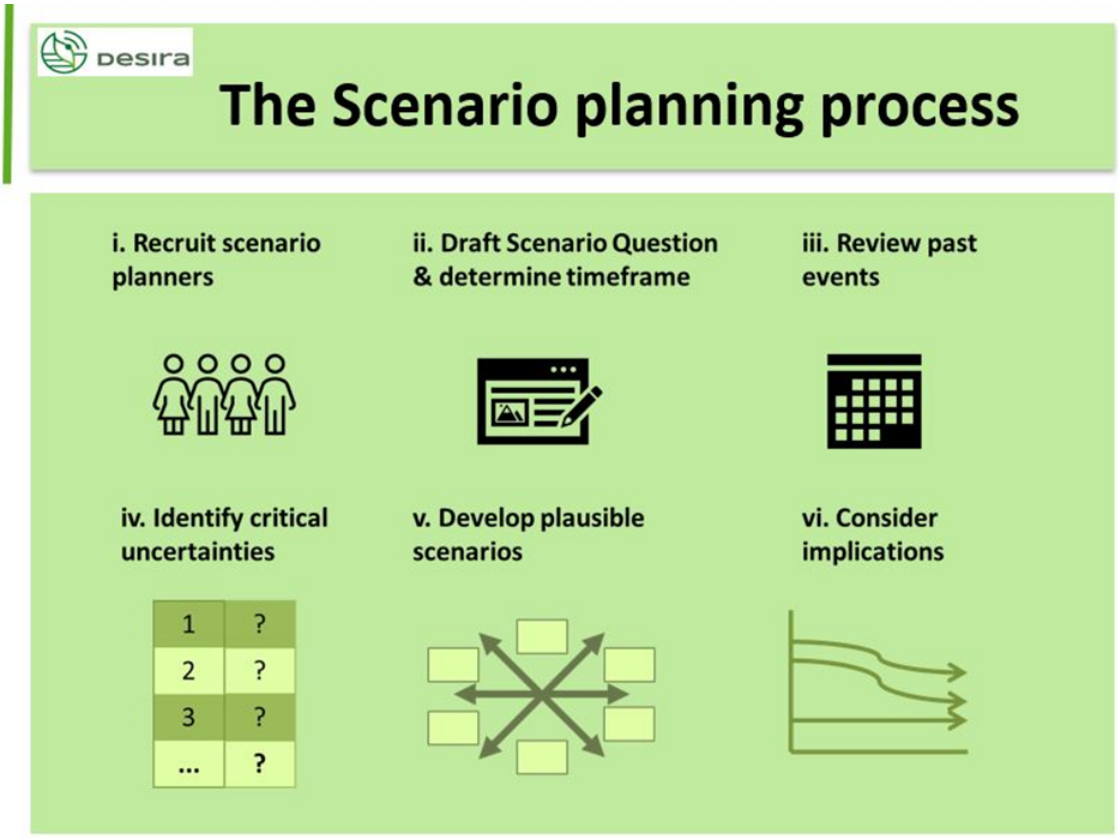
The pandemic has facilitated rapid changes in health care which will continue with improved digital services (ES2). Another way in which the pandemic may have improved rural circumstances is through increased mobilities and demographic renewal in rural regions as the pandemic has increased digital connections and capabilities in rural communities and distance learning opportunities to allow the young to remain in their local rural areas (IT2, SCO) e.g. *"the possibility of using **distance education services**, which at the moment (with the covid-19 pandemic forcing the use of distance learning), are at the limit of acceptability in terms of quality."*(IT2). It also presents the opportunity for new people to migrate to rural communities as digitalisation enables greater flexibility and internet connectivity (GR1, SCO, FI).

However, Covid has had a big financial impact on European economies which may lead to worse case scenarios like that of FR2 where *"Legislation hinders the development of digital technologies (data sharing, precautionary principle…). The weight of the Covid debt prevents any public financing towards companies." FR1*. Migration due to covid was also not all positive and acquiring a seasonal workforce was difficult prior to Covid but has intensified since. More automation could thus help preserve family farms who rely upon these seasonal workers (DE2).

10. Methodology

Scenario planning step by step

Figure 3: Simplified scenario planning process



The process of scenario development was based on one or two workshops carried out by the Living Labs which were run as illustrated in Figure 3. Steps i and ii (along with some elements of the other steps, notably iv and v) were completed before the workshop although a short discussion of the scenario question was in some cases accommodated at the beginning of the workshop. The first workshop was dedicated to the elaboration of four scenario frames (steps iii. to iv.) Prior to the scenario workshop there was a workshop held as part of WP2 with the Living Labs which identified the past and current state of digitalisation in each case. The outcomes of this workshop acted as a starting point for the two scenario planning workshops (see point iii in Figure 3). The second scenario workshop (or second part of the single workshop) completed steps v and vi.

Step i. Assembling of Scenario Planners

Scenario Workshops were held by each Living Lab across the DESIRA regions. Scenario planners were members of the Living Labs, and those who participated in the WP2 workshop (or a subset of them). Where necessary and/or useful, additional people were asked to join the workshop(s). The first

scenario planning workshop session in each Living Lab was followed by a second session each taking approximately 3 hours. The sessions were either held on separate days with an interval, or on the same day. In some cases, the Covid-19 situation compromised the preferred plan to hold face to face participatory scenario planning meetings and these workshops were therefore held online.

Step ii. The Scenario Question and Time Horizon

The Scenario Question

Scenario Question: Because the Living Labs already had the concept of a 'Focal Question' and because scenario planning requires a special, future oriented question (conventionally also called a *focal question*), we defined the term 'Scenario Question' to make a clear distinction between the questions framing the broader LL and the questions framing the scenario planning components of the LL. Scenario questions are about future visions (e.g. what will 2031 be like?). The draft Scenario Question was produced ahead of the workshop and discussed in the workshop with participants, who were welcome to alter the question to better suit the context. It adds legitimacy to participatory scenarios if the participants have their say on the Scenario Question and are given the opportunity to modify or replace it (Duckett *et al*. 2017). While in an ideal participation a blank sheet of paper maximises the control that stakeholders have over the process, in practice there is always a balance to be struck about how much can be achieved in the precious workshop time when the stakeholders will have a steep learning curve and be may be challenged to complete scenarios in the time allowed.

Time Horizon

Methodologically, a **time horizon** is required. Future scenarios are temporally fixed to allow scenario planners to envision a state of play at a specific point in the future. Too far in advance and the scenario becomes highly speculative as the uncertainties mount and of little interest to decision makers with policy cycles to consider; set too near to the present, scenarios lack strategic depth (see Fig. 1.) and may be more appropriate for operational level decision making as opposed to the desired strategic level of most scenario planning. For DESIRA we specified a Time Horizon of 2031 which was also stated in each scenario question. Importantly the objective of scenario planning is to think about current strategy or actions that are needed now in light of future uncertainty. One can think of scenarios as a roadmap from the present to the future.

Step iii: Review of past events

Prior to the scenario planning workshops, the WP2 workshop had already reviewed past and present digitalisation. The outcomes of this previous WP2 workshop provided briefing material for use at the first scenario workshop session (Step iii, Fig. 3). Stakeholders found it helpful to consider a timeline of past events roughly equivalent to the length of time to the future horizon (i.e. the decade from 2011 to the present acts as a prompt for the coming decade until 2031). Looking back at the last decade and events identified by the WP2 workshop while thinking about the Scenario Question demonstrates

to the stakeholders how radically the situation, particularly digitalisation, has changed and therefore how radical future visions need to be.

Figure 4: Example of a participatory 'timeline' exercise

Step iv: Identifying DOC and critical uncertainties

A key concept underpinning scenario planning is that of Drivers of Change (DOC). Myriad ways of conceptualizing drivers have been developed and our approach is robust but not the only one. Most methods proceed by characterizing different types of driving forces: External driving forces (drivers that cannot be controlled by the actors of the scenario (e.g. Geo-political forces) and internal driving forces (parameters that can be influenced by stakeholders within the scenario (e.g. technology adoption). Both internal and external driving forces shaping any given scenario and any future behaviours, can have a high degree of uncertainty associated with them, in which case we refer to them as *Critical Uncertainties*.

One can think of DOC as the scaffolding around which the scenarios are built or as its internal structure. In order to elaborate our scenarios in a way that will give them a level of comparability across the project, we needed a common, underlying structure around which to build plausible narratives about the future. For example, in the case of the Tuscany LL, if stakeholders select 'robotics' to be a plausible DOC for an alternative future affecting the risk of flooding in 2031 it is added to the

list under consideration. Equally, if 'extreme weather events' is a plausible force that may shape flood risk management differently in 2031, it is added to the list.

STEEP

In order to encourage the compilation of an appropriate and broad ranging list, we applied a STEEP analysis. STEEP stands for Social, Technological, Environmental, Economic and Political. It is a simple checklist method to ensure that drivers are selected across multiple domains. It prevents stakeholders becoming too narrowly focused on, for example, economic drivers, whilst neglecting technological dimensions. The approach promotes the identification of DOC for each letter in the STEEP acronym.

Figure 5: The STEEP workshop tool

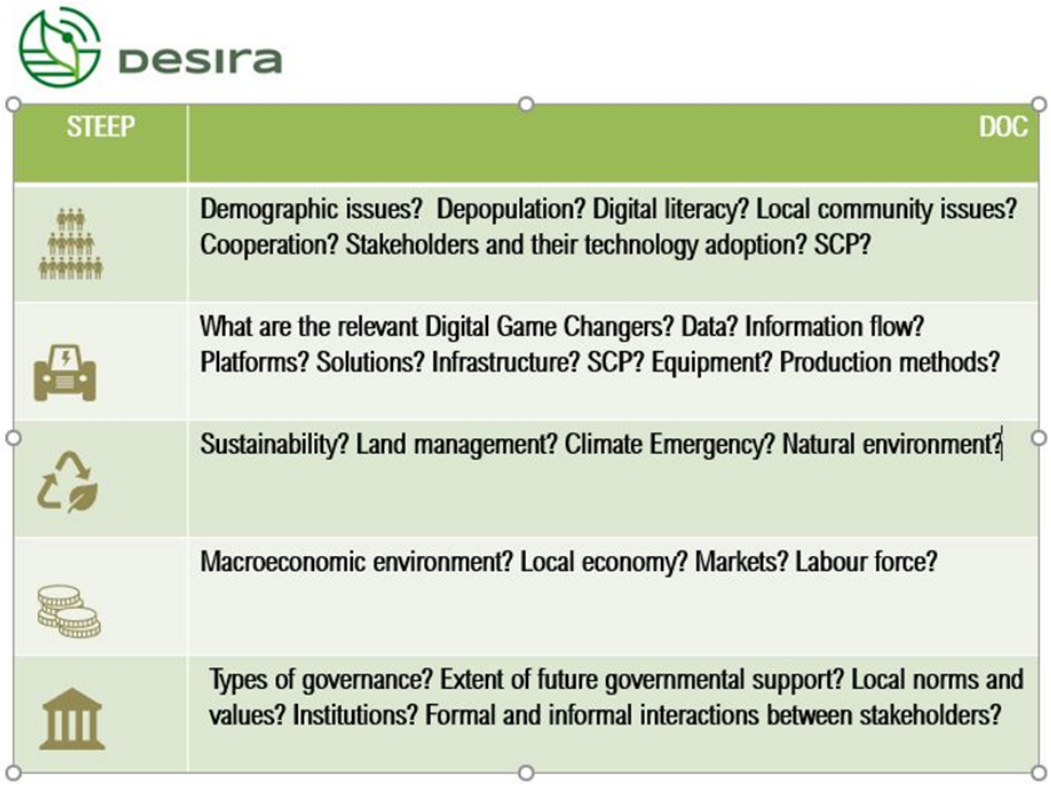
We acknowledge that DOC are not necessarily categorizable in neat and simple boxes. They are typically transversal or able to be seen in different domains by different stakeholders. One stakeholder's technological driver may be another stakeholder's economic driver, for example e-commerce. STEEP was not used to create a taxonomy of drivers but simply to encourage wide ranging thinking. The transversality of many drivers was something noted at the Rural Development Forum meeting and in several Living Labs.

We also recommended to facilitators the pre-preparation of an initial set of drivers before the workshop. Experience dictates that this can be a time-consuming exercise and all elements of scenario building need to be completed in two, constrained workshop days (or sessions). We followed what

has been done successfully in previous exercises – the pre-preparation of a set of drivers, drawing on researchers' background knowledge of the context, for example, existing knowledge about the LL specificities plus information from WD1.3 to select digital game changers. This guided the participatory exercises towards reviewing, modifying or supplementing this preprepared set but did not prevent the addition of DOC at the discretion of the local facilitators. In order to support the preparation of relevant DOC the WP lead compiled a compendium of drivers of change based on a literature search including previous germane scenario exercises.

Given a DESIRA focus on the role of digitalisation in the future, we encouraged participants to consider a combination of technical change and societal/behavioural change. A scenario of a future 'socio-technical system') should then incorporate at least the following types of elements:

Figure 6: Guidance for STEEP DOC



The preprepared set of ~5-10 DOC representing the critical uncertainties and most significant game changers need to have a corresponding set of assumptions. No one knows how or which drivers will influence events given that the future is inherently uncertain, however, scenario planning works by exploring different assumptions about how drivers of change may operate. Workshop organisers developed 2-5 assumptions for each DOC in advance of the first session. This allowed for the development of plausible scenarios.

- Step v: Develop Plausible Scenarios

A number of methods exist allowing the development of scenarios. Each have advantages and disadvantages both methodologically and practically. So that the scenarios developed in each Living Lab could be comparable and for them to form a coherent set, a common, structured approach was required. We employed a variant of morphological scenario methodology. Morphological Scenario Planning is structured around a matrix or Morphological Box. The Matrix contains Drivers of Change

along one axis and a range of plausible assumptions about how they may shape the future along the other. For DESIRA, DOC must include the driving forces of digitalisation, both internal and external and plausible assumptions about how these drivers of change may shape the future. For example, 'low degree of connectivity in the rural area' or 'low level of availability of open data'. In each scenario outline, digital game changers, (DGC) guided by the Taxonomy (D1.3) and by WP2 Workshop 1, alongside other DOC introduced by the participants, were used to populate ~8 rows. DOC therefore, were not exclusively digital entities and should include heterogenous entities.

After selecting 5-10 DOC to be included in the matrix, participants next decided what different states those DOC might plausibly take. This can be binary (e.g. high/low) or more expansive (e.g. high/medium/low), (see figure 7). It was strongly recommended that the facilitators had already developed possible states for the preprepared drivers. This helped participants to understand what was required for any new drivers selected - and participants were also encouraged to challenge and change any states suggested by facilitators. These assumptions were used to flesh out the detail in the morphological box around the DOC.

Figure 7: Morphological Box populated with 4 Drivers of Change (DOC)

STEEP DOC	Assumption 1	Assumption 2 – BAU	Assumption 3	Assumption 4
Digital gender divide	Gap is narrowed. Affirmative action and effective women in STEM policies have created a more level 'digital' playing field.	Gender Gap remains. There are fewer digital opportunities for women. Women have lower levels of technology skills and are paid less in STEM fields.	Gap is widening due to post Covid austerity. GiG economy and lack of effective action around women in STEM have worsened outcomes.	
Connectivity in the rural area & Digital training platforms	Connectivity is HIGH, favourably comparable with UK urban areas with 7G and 8G services available. Digital training platforms are widely adopted.	Connectivity is MODERATE, service provision lagging behind urban areas. 6G is the typical service provision for this area. Adoption of Digital training platforms is limited.	Connectivity is POOR 4G and 5G services limit both opportunities for rural businesses and availability of services in this area. Digital training platforms are rare.	
Ecommerce supporting diversification/ pluractivity	Ecommerce platforms are providing a lucrative market for croft based enterprises.	Ecommerce provides a modest market for croft based enterprises supplementing other incomes.	Ecommerce is a weak driver for croft based enterprises.	Ecommerce platforms are dominated by larger players and act to exclude croft based enterprises.
Rewilding, Native Restoration, Living Landscape	Under a strong Green Recovery, Rewilding and high valuation around Living Landscapes benefits crofting	Under a modest Green Recovery, crofting continues to make moderate progress	Without effective Green Recovery crofting declines	Green Recovery promotes rewilding over Living Landscapes to the detriment of traditional crofting
Crofting support mechanisms	Strong public support is available for crofting inc. payments that safeguard livelihoods	Weak public support for crofting does little to safeguard livelihoods		

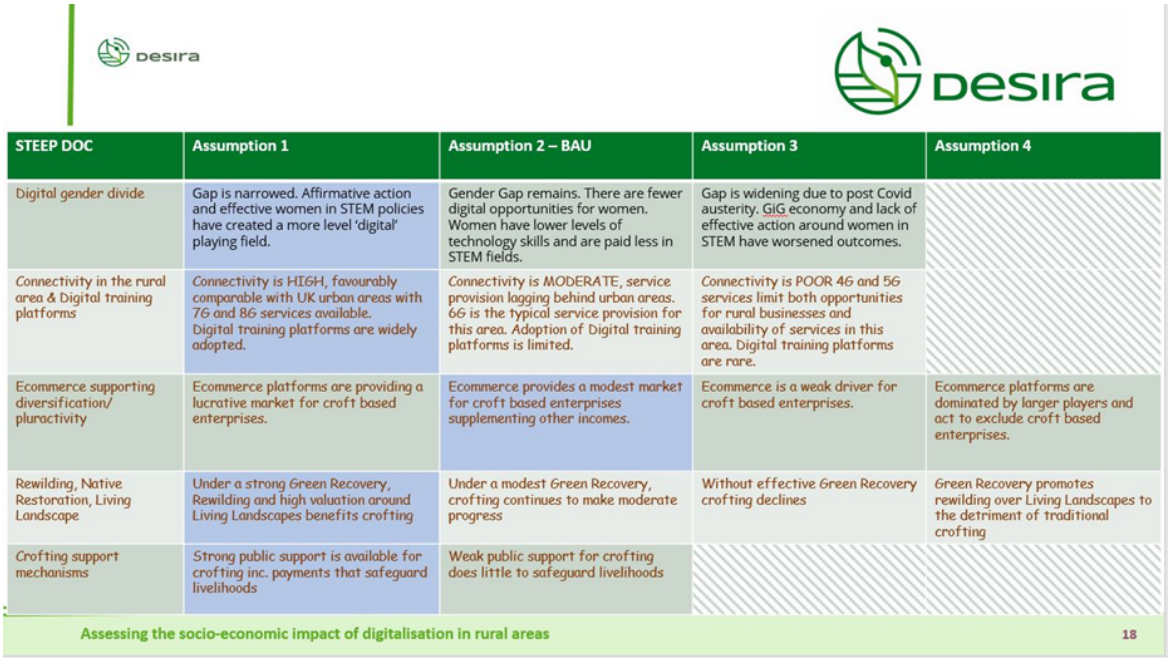
Assessing the socio-economic impact of digitalisation in rural areas 17

The template also organises the assumptions from positive (left) through Business as Usual or BAU (centre) to negative (right). Regarding practical constraints, we needed to limit the complexity of the task and complete it in a timely manner at the workshops. For these reasons we recommended setting a ceiling of 10 DOC and a maximum of 4 states (assumptions) for each. Furthermore, it was recommended that the matrix should cover all 5 STEEP categories. This was to reflect the reality that the future is determined by a heterogeneous set of factors.

Scenario Outlines

The third step to complete the Morphological Box was to consider combinations of assumptions or pathways through the matrix to form outlines of scenarios. In the next example the blue cells represent the outline of one possible scenario. A scenario outline can be thought of as the framework of a scenario. There are hundreds of possible pathways though the matrix. The workshops each selected only 2-4. The pathway must represent a plausible outline or in other words, the set of assumptions must be consistent with one another.

Figure 8: The third stage of matrix construction – selecting a scenario outline



STEEP DOC	Assumption 1	Assumption 2 – BAU	Assumption 3	Assumption 4
Digital gender divide	Gap is narrowed. Affirmative action and effective women in STEM policies have created a more level 'digital' playing field.	Gender Gap remains. There are fewer digital opportunities for women. Women have lower levels of technology skills and are paid less in STEM fields.	Gap is widening due to post Covid austerity. GIG economy and lack of effective action around women in STEM have worsened outcomes.	
Connectivity in the rural area & Digital training platforms	Connectivity is HIGH, favourably comparable with UK urban areas with 7G and 8G services available. Digital training platforms are widely adopted.	Connectivity is MODERATE, service provision lagging behind urban areas. 6G is the typical service provision for this area. Adoption of Digital training platforms is limited.	Connectivity is POOR 4G and 5G services limit both opportunities for rural businesses and availability of services in this area. Digital training platforms are rare.	
Ecommerce supporting diversification/ pluractivity	Ecommerce platforms are providing a lucrative market for croft based enterprises.	Ecommerce provides a modest market for croft based enterprises supplementing other incomes.	Ecommerce is a weak driver for croft based enterprises.	Ecommerce platforms are dominated by larger players and act to exclude croft based enterprises.
Rewilding, Native Restoration, Living Landscape	Under a strong Green Recovery, Rewilding and high valuation around Living Landscapes benefits crofting	Under a modest Green Recovery, crofting continues to make moderate progress	Without effective Green Recovery crofting declines	Green Recovery promotes rewilding over Living Landscapes to the detriment of traditional crofting
Crofting support mechanisms	Strong public support is available for crofting inc. payments that safeguard livelihoods	Weak public support for crofting does little to safeguard livelihoods		

Given workshop constraints of ~10 scenario planners it would be challenging to fully develop 4 scenarios in each LL. Therefore, it was proposed that 2-3 scenarios were fully articulated, and another 2 scenarios were developed in outline form only. The direction was to consider a plausible positive scenario (e.g., Fig. 8 above) and a plausible negative scenario as the main scenarios. These might be regarded as a better (not best) case and a worse (not worst) case scenario and would enable a

systematic exploration of both opportunities and threats respectively. It is often considered good scenario methodology to avoid extremes because history generally reveals more nuanced patterns. The 2 fully articulated scenarios avoid utopian or dystopian characteristics but develop around more plausible good, and plausible bad features.

A third Business as Usual (BAU) scenario was developed in larger workshops wanting to have 3 breakout groups. The BAU outline generally adopted cells from the centre columns of the matrix (either column 2 or 3 depending on whether the number of assumptions), however, BAU also requires plausibility and internal consistency so careful judgement must still be applied.

The 2 scenarios that are not fully articulated were a 'utopian best-case scenario' and a 'dystopian worst picture' containing more extreme elements. These were developed in a less detailed manner in plenary during the second session.

Elaborating scenario narratives

With four scenario outlines determined the next task was to more fully articulate the scenarios. The participants worked with the two intermediate scenarios in breakout groups to 'bring the scenario to life'. There was first a discussion on the plausibility of the scenario outline and a consideration of internal consistency i.e. it must allow a coherent narrative to be told.

This checklist of questions and activities was provided to LL coordinators, to be used in 'bringing the scenario to life'.

- **Ground-truth assumptions – are they plausible – is the set internally consistent**
- **Consider your Socio-Cyber Physical System (SCPS) in 2031**
- **How do the assumptions combine to influence the SCPS?**
- **Who are the winners and losers?**
- **What are the challenges and opportunities?**
- **What uncertainties are present?**
- **What predetermined elements exert influence?**
- **Add detail and colour to the scenario**
- **What is it like to live in this version of the future?**
- **How is daily life different?**
- **How is the community different?**
- **Compare the new SCPS of 2031 with the old SCPS of 2021**

This synthesis report draws on an analysis of the 20 scenario reports that were produced as outcomes of the scenario planning workshops held with the existing living labs established in WP2, details of which can be found on the DESIRA website. The scenario questions were finalised with the workshop participants, and all feature the required year 2031 (Figure 2).

11. References

Bezold, C. and T. Hancock (1993). An Overview of the Health Futures Field in Health Futures in support of health for all World Health Organization.

Cho, Y. (2013). Investigating the merge of exploratory and normative technology forecasting methods. 2013 Proceedings of PICMET '13: Technology Management in the IT-Driven Services (PICMET).

Duckett, D. G., A. J. McKee, L.-A. Sutherland, C. Kyle, L. A. Boden, H. Auty, P. R. Bessell and I. J. McKendrick (2017). Scenario planning as communicative action: Lessons from participatory exercises conducted for the Scottish livestock industry. Technological Forecasting and Social Change 114: 138-151.

Government Office for Science (2017). The Futures Toolkit: Tools for Futures Thinking and Foresight Across UK Government.

Kok, K., M. van Vliet, I. Bärlund, A. Dubel and J. Sendzimir (2011). Combining participative backcasting and exploratory scenario development: Experiences from the SCENES project. Technological Forecasting and Social Change 78(5): 835-851.

Ramirez, R., and C. Selin (2014). "Plausibility and probability in scenario planning." Foresight - The journal of future studies 16.

12. Annex A – Supplementary material

Compendium of drivers of Change DOC

Figure 9: Compendium of drivers of change offered to LLs to inspire their thinking

STEEP	Drivers of Change (DOC)						
	DOC	DOC	DOC	DOC	DOC	DOC	DOC
SOCIETY **Demographics** **Future of Health** **Future of Education** **Changing Values**	Global population growth	Global health including pandemic	Virtual Medical Services	Education services in remote areas	Changing values and aspirations	Gender, Digital gender divide	Urbanization at the local or regional level
	Rural ageing	Inward migration	Gentrification	Rural population density	Dietary change (particularly less meat)	Education level of farmers	Farm succession/new entrants
	Societal demand (for healthy environment)	Societal expectations towards organic	Self-image of organic sector	Manual labour (tedious)	Image of farming		
TECHNOLOGY • **Digitalization**	Public/private Investment in relevant science and technology	Internet of Things & Cloud Computing	Precision agriculture	Robotics	E-commerce	Driverless cars	Drones
	Connectivity in the rural area	Availability of open data	Innovation	Affordability of technology	Digital literacy,	Digital training platforms, Digital outreach	Remote sensing

	Useful Apps	Data hubs, platforms for data sharing	Virtual Veterinary Services				
ECONOMIC • **Macro economy** • **Future of Food**	International trade and globalization of markets	(World) commodity prices (e.g. timber)	Energy Prices	Decentralised energy systems	Distributive Manufacturing	Future of Food – synthetic meat	Poverty
	Availability of Labour force	Availability of investment capital	Rural infrastructure	Supply chain	Ecommerce	Diversification, pluractivity	Costs of labour
	Market situation for (organic) vegetables	Consumer demand	Consumer prices	Costs of technology			
ENVIRONMENT • **Climate Change**	Water scarcity	Extreme weather events (inc. wildfires)	Rainfall variation	Biodiversity	Soil health	Rewilding, Native Restoration, Living Landscape	Environmental awareness
	Availability of seeds/ choice of seed varieties	Energy consumption					

POLICY	Neoliberal markets	Protectionism	International climate accord	Extension services / AKIS	Subsidies, CAP	Green Recovery	Strength of governance (particularly relevant for forestry)
	Security of tenure	Crofting Arrangements inc. subsidies	Legal framework for pesticide use				