NEFERTITI Conceptual Framework

Concepts and Key Factors for Successful Network Establishment

NEFERTITI
Networking European Farms to Enhance Cross Fertilisation and Innovation Uptake through Demonstration
NEFERTITI Conceptual Framework: Concepts and Key Factors for Successful Network Establishment

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Author(s): **Annie McKee, Lee-Ann Sutherland, Laure Triste, Heidrun Moschitz, Fleur Marchand**

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Introduction

What is a conceptual framework?

A conceptual framework provides an 'entry-point' for transdisciplinary groups to compare and clarify definitions of key terms, and to develop a consistent understanding of their problem situation (Potschin-Young et al., 2018). As Gurevitch and colleagues explain, the conceptual framework aims to: "define connections and elements of knowledge in a general area of inquiry, giving coherence and direction to the study of empirical problems" (2011: 408).

This conceptual framework aims to link the practical work of the NEFERTITI project with the theoretical assumptions that underlie these activities. Other Horizon 2020 projects have identified the value of conceptual frameworks in supporting collaboration between mixed groups with different types of expertise (e.g. H2020 AgriLink, PLAID, AgriDemo-F2F). Developing a conceptual framework is thus a key step in the early stages of a multi-stage and multi-actor project such as NEFERTITI.

This document includes the key concepts and theories that underpin the NEFERTITI project aims and provides a common glossary of definitions. It is a 'living document', accessible to the range of scientific and professional expertise within the project. Visual representations of the key concepts will be developed, and the conceptual framework refined through iterative feedback from project participants. Table 1 outlines the components of this conceptual framework.

Table 1 Conceptual Framework Objectives

Component of framework		Objective
1.	**Introduction**	To outline the purpose of conceptual framework, NEFERTITI project context, and project aims and structure
2.	**Major concepts and theories**	To provide common definitions and theoretical basis for the network activities within the NEFERTITI project
3.	**The NEFERTITI networks and key factors**	To provide a theoretically grounded basis for the development of demonstration farm networks in the NEFERTITI project
4.	**Glossary of key terms**	To provide common and easy-to-use definitions for the key terms and concepts used within the NEFERTITI project

Context for NEFERTITI

Demonstration activities have been important knowledge exchange mechanisms in European agriculture for several hundred years. Recently, there has been renewed interest in the role of on-farm demonstration in facilitating farmer learning and innovation. This interest reflects the growing recognition of the importance of increasing the knowledge and innovation potential of European farmers, to enable them to meet increasing societal expectations and tackle the challenges of food security, food safety, quality, sustainability and climate change.

In the past, knowledge transfer has been conceptualized as a linear process of passing on new research-based knowledge to farmers. Recent research demonstrates that innovation and up-take of new farming technologies or practices result from iterative engagement in non-linear knowledge networks or systems (cf.

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Wielinga et al., 2017; Faure et al., 2017). Learning and innovation are now conceptualised as resulting from networks, in which innovation is 'co-produced' through interactions between all stakeholders in the food chain. This is the AKIS - Agricultural Knowledge and Innovation System (EU SCAR, 2012).

NEFERTITI is integrated into a set of projects that "set up network activities between geo-referenced demo-farms dealing with specific themes across Europe with a view to exploiting their potential to improve delivery of practice-oriented knowledge and enhance interactive activities" (Source: original call text). NEFERTITI will build on the inventory of demonstration farms produced by the H2020 projects PLAID and AgriDemo-F2F (jointly branded as 'FarmDemo') to establish ten thematic networks of demonstration farms across Europe, across the topics of animal production, arable production, horticulture, and new entrant farming[1]:

1. Grassland and carbon sequestration
2. Data driven decisions for dairy farmers
3. Organic livestock systems
4. Soil quality in arable crops
5. Arable crop sensing and variable rate applications
6. Organic arable crops
7. Nutrient efficiency in horticulture
8. Water use efficiency in horticulture
9. Reducing pesticides in grapes, fruits and vegetables
10. Increasing farm attractiveness to new entrants

NEFERTITI is one of a series of projects[2] funded by the European Commission to consider how to improve farm efficiency and innovation up-take, through improved agricultural knowledge and innovation systems. Members of the NEFERTITI consortium have been involved in all of these projects. Relevant forthcoming calls in the 2018-2020 Horizon 2020 work programme include RUR-13-2018: Enabling the farm advisor community to prepare farmers for the digital age and RUR-16-2019 Fuelling the potential of advisors for innovation.

NEFERTITI will implement the best practices recommended by PLAID and AgriDemo-F2F, providing useful cross fertilisation with AgriLink's innovation areas. As a Coordination and Support Action, NEFERTITI will focus on assembling existing knowledge, rather than conceptual development and new empirical research[3]. Furthermore, NEFERTITI will build on AgriDemo-F2F and PLAID project results concerning the key success factors for demonstrations in terms of learning by farmers, adoption of the demonstrated new techniques and improved networks and activities between stakeholders.

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[1] Network descriptions are included in Section 3.

[2] 7th Framework Programme SOLINSA (Support of Learning and Innovation Networks for Sustainable Agriculture) (2011-2014), FP7 FarmPath (Farming Transitions: Pathways towards regional sustainability of agriculture in Europe) (2011-2014), FP7 PRO AKIS (Prospects for Farmers' Support: Advisory services in European AKIS) (2012-2015), FP7 VALERIE (VALorising European Research for, Innovation in agriculturE and forestry) (2013-2017), H2020 AgriSpin (creating SPace for INnovation in Agriculture) (2014-2016), H2020 PLAID (Peer-to-Peer Learning: Accessing Innovation through demonstration) (2017-2019), H2020 AgriDemo-F2F (Building an interactive AgriDemo-Hub community: enhancing farmer to farmer learning) (2017-2019), H2020 AgriLink (Agricultural Knowledge: Linking farmers, advisors and researchers to boost innovation).

[3] PRO AKIS, AgriSpin, PLAID, AgriDemo-F2F and NEFERTITI are all Coordination and Support Actions. SOLINSA and AgriLink are Research Actions. Some empirical research was undertaken in PRO AKIS, and will be in AgriDemo-F2F and PLAID, but research is not included in NEFERTITI.

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NEFERTITI project aims

The overall aim of NEFERTITI is to establish an EU-wide highly connected network of well-specified demonstration and pilot farms, which is designed to enhance thematic knowledge exchanges, cross-fertilisation among actors and efficient innovation uptake in the farming sector through peer-to-peer demonstration of techniques.

To achieve this goal, NEFERTITI will undertake the following steps:

(i) Develop 'Dynamic Action Plans' at the level of the network, by identifying the needs of demonstration actors, in terms of knowledge and 'know-how' for networks' activities, taking into account the diversity of EU AKIS (see D1.3 Dynamic Action Plan Guide).

(ii) Support annual cycles of demo-activities and peer-to-peer learning in the regional hubs that will be established involving all relevant AKIS actors. This objective aims improve the uptake of knowledge among farmers and improve science-practice interactions;

(iii) Establish a web-based platform including knowledge reservoirs related to demo-activities including ready-to-use knowledge from other national, EU and EIP related projects organised by themes and sectors.

(iv) Establish and sustain interactive thematic networks at regional, national and EU levels by sectors and themes (and with the EIP related projects/landscape) to boost knowledge exchanges and cross fertilisation;

(v) Foster the learning process of all actors involved in demo-activities throughout the networks to identify best practices for demonstrations and interactivity between demonstrations on similar themes over Europe;

(vi) Improve the policy dialogue and networking the regional European Structural Investment Funds (ESIF) managing authorities to ensure the network sustainability;

(vii) Promote effective use of demo-and network activities by communicating and disseminating the practical-oriented outcomes adapted at local level.

Structure and responsibilities of NEFERTITI

NEFERTITI will establish 10 thematic networks. These networks will be comprised of regional clusters (or 'hubs') of demo-activities and the involved actors.

What is a hub?

Organised at regional or national level, a **hub** is a group of several demo-farms working on a given topic/challenge (crossroad of a sector and theme) and connected to relevant AKIS actors and stakeholders (R&I, farming sector, education, industry, cooperatives, SMEs, etc.) and their facilities.

Each hub in the NEFERTITI project will be supported by a '**hub coach**'. A hub coach is a project partner managing the hubs' activities. The coach connects all relevant AKIS actors and stakeholders around the hub in order to boost knowledge exchange and cross-fertilisation around demonstrations. The coach is connected to the other hubs' coaches of the same network, as well as other hubs in other NEFERTITI networks.

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What is a network?

Organised at EU level, a **network** connects several regional/national hubs. Each thematic network thus constitutes a cross-border multi-actor interactive network of demonstration farms and the AKIS actors from several EU countries working on the same topic/challenge and exchanging practical oriented knowledge, farm best-practices, and relevant innovations.

A **network leader** is a coach managing the network activities. They will harvest ready-to-use material and knowledge from relevant EU projects, organise concrete knowledge exchange activities within the network (knowledge virtual and face-to-face meetings, field cross-visits, etc.), and are responsible for cross-fertilisation with the other NEFERTITI networks.

What is a demonstration farm?

Demonstration activities can be organised on many farm types, such as experimental or research farms (linked to institutes and universities), charitably owned farms (owned by trusts and charitable organisations) and commercial farms (owned by private citizens and limited companies). On-farm demonstrations range from one-off 'field day' events established by input suppliers; to multi-year 'monitor farms' where farmers, advisors and industry members come together at regular intervals to assess farming opportunities in situ; to permanent 'research farms' where researchers demonstrate cutting edge technologies and approaches. Increasingly, farmers themselves are 'opening up' their farms for engagement with their peers and the general public as part of business development strategies, using both traditional and new virtual 'on-line' methods. Demonstration farms thus vary according to several different parameters, including ownership status, goals and objectives, the alternative functions involved, the actors/networks involved in each demonstration function and their roles, the audience, the network structure, its openness etc. They can also differ in terms of their frequency; hosting demonstrations in the long-term (e.g. long-term experiments), short-term (e.g. monitor farms) or annually/seasonally (Koutsouris et al. 2017). The AgriDemo-F2F project adopted the following definition:

> *Demonstration farms can be defined as meeting places where dissemination of knowledge and information is taking place, advice is provided, solutions and tools are designed and implemented as well as controlled, on-the-farm research is conducted (Kiełbasa and Kania, 2015). Educational opportunities come from the application or demonstration of results or methods, training opportunities and the ability to exchange experiences throughout open events and other dissemination actions (Kiełbasa and Kania, 2015; EISA, 2010; Syngenta, 2016; in Koutsouris et al., 2017).*

Furthermore, the PLAID project uses the following definition:

> *Demonstration farms are educational centres for experience-based learning that promote the practical viability of new or improved farm management practices and technologies through seeing and discussing. They place a particular focus on understanding innovation within a working farm context, within a local setting and across the different stakeholder groups involved. While they focus on the demonstration of known "best" or "good" practices, experimental work may also be conducted, particularly in a learning-by- experiment context (Burton, 2017; PLAID conceptual framework).*

NEFERTITI will build on both definitions to establish an EU-wide network of demonstration, designed to enhance thematic knowledge exchanges, cross-fertilisation among actors and efficient innovation uptake in the farming sector through peer-to-peer demonstration of techniques.

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What are demonstration events?

The authors of the AgriDemo-F2F conceptual framework explain: *"on-farm demonstrations facilitate an effective learning situation for farmers to 'see the crops themselves', 'interact with the scientists and extension workers on the field', and 'get doubts clarified themselves' (ICAR, n.d.). On-farm demonstrations allow farmers to see a new/innovative technology, practice or system in operation on a working farm not too dissimilar to their own and talk to someone actively engaged in the practice and to whom they can relate (their peers). This is especially true for those technologies that are costly, complex, or require a major shift in the operation (Miller and Cox, 2006; Bailey et al., 2006)"* (Koutsouris et al., 2017:3).

In this context, a demonstration event can be defined as, proposed by the Agridemo-F2F project:

> *The diverse means for providing farmers with "an explanation, display, illustration, or experiment showing how something works" (Collins English Dictionary) that can be subsequently applied in their own farming practices to bring about positive changes on their farm. In broader terms demonstrations can be seen as an important part of AKIS that represents "the function of providing need- and demand-based knowledge in agronomic techniques and skills to rural communities in a systematic, participatory manner, with the objective of improving their production, income and (by implication) quality of life" (Haug, 1999 as cited in La Grange et al., 2010: 261).*

As a result, Koutsouris and colleagues explain that "a demonstration, commissioned and organised by a variety of actors within and outside AKIS, may be multifunctional and multipurpose with broad-interrelated features incorporating a farming system approach or less complex focusing on a single practice and individual farm components" (Koutsouris et al. 2017:31).

This project structure is underpinned by key concepts and theories, which will be outlined in Section 2.

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MAJOR CONCEPTS AND THEORIES

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Major concepts and theories

The NEFERTITI project promotes a network approach instigating and supporting 'multidisciplinary and intersectoral innovation groups' in 'processes of knowledge co-creation and social learning' (cf. Hermans et al., 2015: 36). The project's network leaders will engage with the concepts outlined in this Section, to ensure that the thematic networks fill knowledge gaps and support/evidence farming best practices, as well as uptake of innovative technologies. The hub coaches will act as network facilitators/brokers to support the activities of the demonstration farms, to ensure effective communication, and the development of trusting relationships between network members. Their tasks will be underpinned with an understanding of and critical perspective on network theories (e.g. social network theory, partnership development, etc.), social learning, and social capital. To achieve this, the major concepts relevant to the NEFERTITI project are explained below (see Box 1). Also based on this literature, we derive six key factors in network development through which this theoretical perspective is interpreted. These key factors give practitioners more concrete levers to set up their network and are further elaborated in Section 3.

Box 1: Summary of key concepts

- Demonstration is embedded in **AKIS**.
- The purpose of demonstration is to increase development and up-take of **agricultural innovations**, both science driven and innovation driven.
- These innovations are intended to increase the **sustainability** of farms and the agricultural sector over the long term.
- Up-take of innovations through demonstration is achieved by **peer-to-peer learning**, and by experiential learning facilitated by farmers and industry experts.
- **Networking** these actors involved in demonstration and supporting existing and new **demonstration activities** is how NEFERTITI will increase innovation up-take on farms.

AKIS (Agricultural Knowledge and Innovation System)

AKIS can simply be defined as "the collection of agricultural information providers, the flows of information between them, and the institutions regulating these relations" (Sutherland et al., 2018). The term AKIS (Agricultural Knowledge and Innovation System) is commonly utilised in European policy documents, and in the name of the Standing Committee for Agricultural Research AKIS Strategic Working Group (SCAR AKIS SWG).

Klerkx et al. (2012) highlights two different aspects of 'AKIS'. Therefore, whilst some projects (e.g. FP7 PRO AKIS) emphasise the AKIS infrastructure: the actors (e.g. advisory services, research institutions, farming organisations), rules, regulations and physical infrastructure, which directly influence innovation outcomes, other projects, like SOLINSA, emphasise the interactive development of technology, practice, markets and institutions. NEFERTITI seeks to enroll all the relevant AKIS actors in each hub, to promote interactive learning about new technologies, practices and markets.

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Also relevant for NEFERTITI is the concept of LINSA: 'Learning and Innovation Networks for Sustainable Agriculture'. The SOLINSA project defined LINSA as: "networks of producers, users, experts, CSOs, local administrations, formal AKS components, SMEs that create mutual engagement around sustainability goals in agriculture and rural development, and to this purpose they co-produce new knowledge by creating conditions for communication, share resources, cooperate on common initiatives" (Moschitz and Home, 2012: 3). The emphasis within NEFERTITI is about sharing knowledge within the thematic networks, regarding innovative and good practice, adapting this knowledge to new contexts, and facilitating active implementation.

NEFERTITI's overall aim is to realise added value from connecting existing and new initiatives of EU demonstration and pilot farms on thematic level, improving knowledge flows. Moreover, NEFERTITI sees a potential role for networks to improve the bottom up influence on research programmes, improved dialogue and fertile ground to initiate new projects and innovations.

Agricultural innovation

The purpose of NEFERTITI is to facilitate efficient innovation uptake. The European Commission's Standing Committee on Agricultural Research AKIS SWG reports draw on OECD (2009) definitions of innovation:

> *An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations. Innovation activities are all scientific, technological, organisational, financial and commercial steps which actually, or are intended to, lead to the implementation of innovations. These activities themselves need not to be novel, but are necessary for the implementation of innovations* [4].

This definition emphasises that innovation can be technological, economic, environmental or social. In NEFERTITI, it is recognised that what is an 'innovation' in one region, may be commonplace in another; innovation may also be an incremental improvement of an existing technology or process. Enabling innovation is about changing systems – the social norms, legal structures, institutions and markets in which innovations and farms are embedded (Smith et al., 2010; Kilelu et al., 2011). Through multi-actor processes and partnerships, learning and change can lead to co-development of innovations which are adapted and responsive to particular contexts (Klerkx et al. 2012). Wielinga and colleagues (2017) describe seven key stages in an innovation process, known as an 'innovation spiral' (or the 'spiral of initiatives'), namely: (i) initial idea; (ii) inspiration; (iii) planning; (iv) development; (v) realisation; (vi) dissemination; and (vii) embedding (2007 *in* Wielinga et al., 2017). The 'innovation spiral' is a shift from the classical, linear perspective on innovation (cf. Rogers, 2003). The more dynamic, nonlinear, and network-focussed understanding of innovation is best suited to NEFERTITI given the project aims (after Faure et al., 2017).

Wielinga et al (2017) explain that innovation is viewed as a systematic and interactive process that emerges from social networks, as well as a technical, non-linear process, contributing to interactive learning (Koutsouris, 2014 *in* Wielinga et al., 2017). A conceptual shift has occurred from the 'technology transfer' model of innovation, to an approach of networks and systems, including agricultural innovation systems, which are in turn seeking to adopt multi-stakeholder learning approaches (Wielinga et al., 2017). The network approach, and the role of network leaders and facilitators will be considered in a later sub-section, but it is pertinent to

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[4] The Oxford English dictionary defines 'to innovate' as to "make changes in something established, especially by introducing new methods, ideas, or products". 'Innovation' is defined as the action or process of innovating.

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highlight the importance of network management and facilitation skills, as well as human capacities and management strategies (cf. Faure et al., 2017; Klijn et al., 2010).

Indeed, the SCAR AKIS SWG definition also emphasises that supporting innovation is a process – it is about enabling progression through steps to develop and implement an innovation. As the AgriSpin project explains, innovation support is based on connectivity and 'building bridges' (Wielinga et al., 2017), and an 'innovation support service' (ISS) can be understood as "either an organisational body or actor (service provider[5]), or as an activity" (Albert 2000 *in* Faure et al., 2017). Within the AgriSpin typology of the functions of ISS, a key component is network facilitation and brokerage, in particular the activity of 'organising or strengthening networks, improving relationships between key actors, and aligning services in order to complement each other, as well as strengthening collaborative and collective action' (after Mathe et al., 2016 *in* Ndah et al., 2017; see also Faure et al., 2017). This is the primary goal of the NEFERTITI project. However, Sartas et al. state that the "size and connectivity of an innovation network influence the likelihood of successful innovation and scaling" (2018: 8), and the 'intensity of intermediation' (or network facilitation) is determined by the type of innovation and its scale, thus: "while adapted coordination and knowledge sharing mechanisms are required at local level for innovation, intense intermediation and institutional dialogue are required for addressing scaling issues are value-chain or territorial level" (Faure et al., 2017: 12; see also van Lente et al., 2003). The latter demonstrates the requirements on network leaders and hub coaches with regard to innovation support and network facilitation in NEFERTITI.

It is important to note that innovation is not inherently 'good' (Klerkx et al., 2010: 458). Innovations have both costs and benefits and are unlikely to have the same impact on all farms. Supporting certain innovations can disproportionately benefit particular types of farms. The decision not to adopt an innovation can be a rational choice at farm or industry level. There are also sustainability trade-offs in what innovations can be expected to achieve (Nelson and Nelson 2002, Tuomi 2002). This is addressed in the following sub-section.

Sustainability

Sustainable agriculture is a key theme of the call text to which the NEFERTITI project responds: "projects should cover a wide range of themes to be chosen according to where most added value for the EU is to be expected and should contribute to a more sustainable and resilient agriculture and forestry" (call text).

The European Commission's 2012 brochure "Sustainable agriculture for the future we want" (EC, 2012: 2) employs the triple bottom line approach to sustainability:

> *"The delivery of public goods such as environmental benefits is closely interlinked with the capacity of agriculture to be economically sustainable, generate adequate family income, and be socially sustainable. The thrust is to improve the quality of life in rural areas."*

This definition has its early origins in the Brundtland report on sustainability (WCED, 1987) and suggests that there are three main dimensions to sustainability – social, economic and environmental. Sustainability is achieved when these dimensions are balanced in a way that all three can be maintained simultaneously in the long term (Murphy, 2012). The NEFERTITI networks will fuel interactive innovation projects and approaches,

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[5] Faure et al (2017) explain that 'service provider' could include advisory services, extension organisations, bridging or intermediary organisations, etc. Service provision depends on characteristics such as: governance, mandate, funding, and human capacities, e.g. of the advisors.

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to contribute to in particular a more competitive, climate-smart agriculture and forestry, while respecting social desirability. In practice, some innovations will achieve one or two of the sustainable development dimensions at a cost to the other. These trade-offs will vary depending on context and can contribute to explanations of variable adoption rates.

Due to the time-step of innovation uptake but also of the learning process and considering the measurable impact of these activities on the long term, NEFERTITI will encourage thematic knowledge exchanges and relationships among EU demo-farms and demonstration hubs in view of the sustainability of 'human-level' and professional relationships among farmers, and other actors, after the four years of the project. This goal reflects the wish to establish a project legacy, and to ensure the continuity of networks established/enhanced within the time of the NEFERTIITI project. However, motivation for ongoing participation in the NEFERTITI networks, and therefore long-term project 'sustainability' (i.e. legacy/continuity), may depend on further funding support, the diversity of activities, a review of network goals, and the opportunity for new stakeholders to join the network (Sartas et al., 2018). The stages of network development are considered in a later sub-section.

Peer-to-peer learning

The starting point for NEFERTITI is that on-farm demonstration plays an important role in farmer-to-farmer learning and the effective transfer of farming best practice and innovative technologies. Recent research has demonstrated consistently that "other farmers" are farmers' most frequently reported source of information (Faysse et al., 2012; Garforth et al., 2003). Songsermsawas et al. (2016) explain that farming peers[6] (including other farmers, but also family members, relatives, friends, and social or religious connections) are an important mechanism in the dissemination of information about new technologies, credit, recruiting labour, household decision-making, and risk mitigation, as well as input use, land allocation, and sales revenues.

Cooreman et al. (2018) states: "Peer learning between farmers suggests a two-way (or more), reciprocal learning experience. One can be more knowledgeable on a certain topic, but can still learn through explaining, listening, discussing and working together with the other, who might be more knowledgeable on another topic. This reciprocity presents a first important shift from traditional learning. It requires initiative, active participation and engagement of the learner towards the own learning process, in contrast to traditional learning where learners are rather required to passively soak up knowledge transferred to them by a hierarchically more knowledgeable person." Cooper (2002:54) addressed this feature by explaining: "Peer learning represents a major shift in focus from what is being taught to what is being learned, and transfers great responsibility for knowledge acquisition, organization, and application from the teacher to the student". This 'ownership' of the learning process by the learner is an important distinction in comparison with more traditional learning approaches and the more traditional 'transfer of knowledge' view, where the teacher (usually researcher in this context) doesn't expect input that can significantly change the focus of the learning process by the listener-learners. As an example of research supporting a peer learning approach between farmers, Curry et al. (2012) reports on the importance of networks in which farmers develop knowledge and innovation from the 'bottom up', through mechanisms of sharing experiences and learning together. Furthermore, peer learning, in educational theory, involves learners learning from and with each other on a scale anywhere between informal and formal learning. The emphasis is on mutual learning since the roles of teacher and learner are not necessarily defined and can alternate throughout the learning experience (Boud, Cohen, & Sampson, 1999).

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[6] A peer is a person who is equal to another considering a combination of certain abilities, qualifications, age, background, or/and social status, relevant to the learning context.

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Numerous examples of peer-to-peer training movements have developed worldwide within agricultural communities. In addition to the Farmer Field Schools (FFS), started around the 1980's and based on adult learning theories and learning-by-doing (Feder, Murgai, & Quizon, 2004), the "campesino-a-campesino" (farmer-to-farmer) movement has promoted agro-ecological techniques over the past 35 years in Latin-America. These approaches from development processes have increasingly been recogised as also helpful in so-called developed countries. Further, smaller, European example is ALMO. This is a bottom-up Austrian farmer's initiative, concentrating on sustainable Alpine oxen beef farming (Karner, 2009). These are practices that include peer learning, and it is important to emphasise that peer learning is not a single practice. It covers a wide range of different activities, each of which can be combined in different ways in order to suit the needs of a particular learning context (Topping, 2005).

Taking into account the above, it is not surprising that farmers tend to be most influenced by proof of successful farming methods by their peers (Kilpatrick and Johns, 2003; Warner, 2007; Schneider et al., 2009; Hamunen et al., 2015). This kind of research also suggests that farmers are open to and value the practice of peer learning. In industrialized countries, however, it is argued that this type of collaborative learning has become increasingly marginalized (Hassanein, 1999). Agriculture has historically been a highly visual profession (evident in 'roadside farming' – the practice observing neighbour actions from the roadside). Industrialized agriculture has led to more competition between farmers, and less visual practices (e.g. in indoor spaces characteristic of intensive production, where access is restricted). As a result, while farmers can readily identify the 'good farmers' that they would emulate (Burton, 2004; Burton et al., 2008; Sutherland et al, 2011; Haggerty et al., 2009; Saugeres, 2002; Stock, 2007), not all information is willingly shared. Farmers demonstrating their innovations risk losing competitive advantage (Garforth et al., 2003). Overcoming this barrier is a key component of successful demonstration.

The role of demonstration activities in innovation and learning

A particular form of peer-to-peer learning, demonstration farms are just one of a number of potential sources of information for farmers: information is also available through social media and the Internet, advisors, regulators, supply chains members as well as farming neighbours.

A literature review undertaken by the PLAID project (Burton, 2017) identified the following three key benefits of on-farm demonstration:

1) Strong emphasis on experience-based learning. By enabling farmers to see and discuss possible future innovations and discuss how these work with experts and the farmers themselves, demonstration farms can demonstrate local suitability and practical implementation strategies.
2) Enabling innovations to be seen in the wider farm context and/or over an extended time period. 'Monitor farms', for example, enable repeated engagement with an innovation, to observe how it progresses over time.
3) Focus on "best" or "good" practices. Although peer-to-peer learning is more effective when demonstration occurs on 'typical' farms (Bailey et al., 2006), the location and topics should be selected to demonstrate optimal solutions to common agricultural problems.

These three components are embedded in the NEFERTITI definitions of demonstration farm (see Section 1). Demonstrations reflect the widely-accepted effect of 'seeing is believing'; the power of experiencing new things by seeing them and discussing them on the spot. Demonstrations are meeting and network places offering opportunities for farmers and other industry actors to meet.

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To understand how demonstration activities can be effective in reaching the aforementioned benefits, the AgriDemo-F2F project unravelled the structural and functional characteristics of demonstration activities (Fig. 1). Demonstration activities can differ according to the actors/networks involved and their roles, the audience/attendees, the network structure and its characteristics, resources, finances and incentives, and characteristics related to the farm (geographic location, accessibility, etc.). Furthermore, looking in depth at the functional and organisational processes related to demonstration activities, the literature identifies many different aspects: from coordinating effective recruitment, developing appropriate interaction approaches and conducting appropriate demonstration processes to enable and facilitate learning. The AgriDemo-F2F project also observed very diverse mediation techniques, tools and follow up activities (Koutsouris et al. 2017).
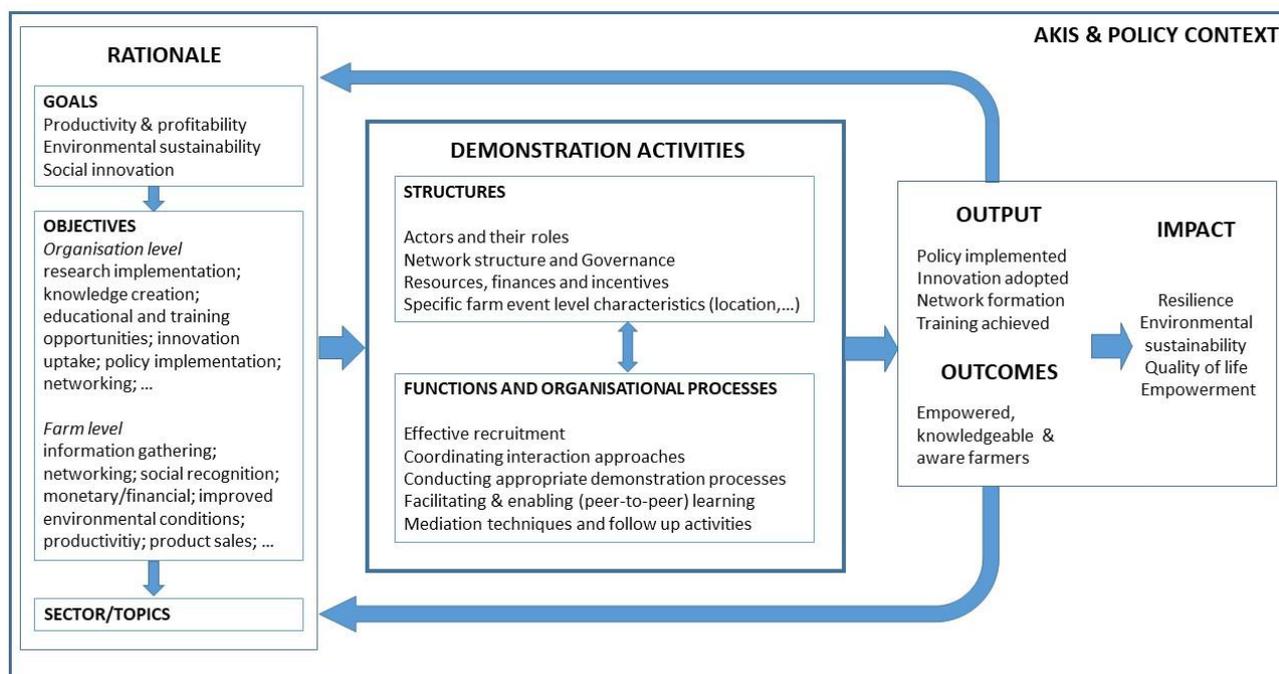

Figure 1. Main building blocks of effective demonstration activities (Koutsouris et al. 2017).

In terms of the effectiveness of demonstration farms, evidence of on-farm change is difficult to measure, owing to the range of information sources farmers can use to change on-farm practices. Several studies have reported up-take of innovations following farm visits (e.g. Bailey et al., 2006; Roderick et al, 2000); however, Hill et al. (2017) raised questions about the cost-effectiveness of these achievements. Organising an event involves considerable staff time, catering and other expenditures. On the other hand, given farmers' appreciation of demonstration farms and their continued use for commercial demonstrations, it may be that positive outcomes are apparent not only as measurable economic outcomes but also as non-quantifiable outcomes (e.g. successful farm succession, farm-level resilience), and that these outcomes nevertheless contribute to sustainable agriculture over the long term.

A key goal of NEFERTITI is to foster peer-to-peer learning on demonstration farms, to boost knowledge absorption and to stimulate collective learning by commercial 'demo-farmers' to improve the impact of their demonstration activities. To achieve this overall goal, and measure success of demonstration activities in NEFERTITI, the project will also create and facilitate monitoring and evaluation of both regional learning processes and interregional knowledge exchange within demonstration networks. The evaluation process will inspire and catalyse the acceleration of (mutual) cognitive, social and institutional learning processes, as well

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as horizontal knowledge flows between peers. Furthermore, based on Agridemo-F2F and PLAID outcomes, NEFERTITI will also capture and share practices, and methods, to improve collective peer-to-peer learning on demonstration farms, as well as to organise self-monitoring and evaluation of these practices and methods, as well as collective learning, to enhance the learning process of farmers within the NEFERTITI demonstration networks.

A network approach and network formation

The challenges facing agriculture in Europe are complex and require multi-stakeholder participation to ensure a sustainability transition (Hermans et al., 2015; see also Sartas et al., 2018). A network approach is therefore promoted that involves 'multidisciplinary and intersectoral innovation groups' in 'processes of knowledge co-creation and social learning' (Hermans et al., 2015: 36). The formation of such networks is central to the activity of the NEFERTITI project.

The FP7 SOLINSA project define networks as: "relational patterns that enable flows of resources" (Brunori et al., 2013: ii), where knowledge and innovation techniques are key resources to circulate through a network (Klerkx et al., 2010). The role of networks is therefore to disseminate information, ideas, provide access to resources, capabilities and markets, and to allow the assimilation of different areas of knowledge" (Cassi et al., 2008 *in* Giest and Howlett, 2014: 39). It may be further added that networks therefore facilitate innovation (Koutsouris, 2018). Podolny and Page describe networks to be: "any collection of actors that pursue repeated enduring exchange relations with one another" (1998 *in* Oreszczyn et al., 2010: 405), and can emerge due to positive or negative incentives (Giest and Howlett, 2014). Social network theory values the ties between individual actors in a network, and their strength of relationship, more so than the individual's competences and practices (see Oreszczyn et al., 2010: 405). Social capital is therefore a key component of network formation, and can in turn be reproduced by the network, while enabling the transfer of tacit, practical knowledge (cf. Granovetter, 1973 *in* Sutherland et al., 2017).

Lambrecht et al. identify three broad types of elements relating to the structural dimension (i.e. the physical characteristics, management and governance) of networks (Lefebvre et al 2010 in Lambrecht et al. 2018):

- Network configuration: the pattern of linkages between network members.
- Network membership: the composition of the network (e.g. the number and type of members).
- Network ties: the relationships between network members (e.g. the frequency and intensity of interaction).

The governance of networks can involve institutions and authorities working in collaboration to "direct, administer and control joint actions across the whole network", or the self-government by the network members themselves (Lambrecht et al. 2018: 2). Furthermore, network governance mechanisms can be formal or informal, based on contractual arrangements or trust-based relationships (Lefebvre et al., 2010 *in* Lambrecht et al. 2018)[7]. Trust is recognised as a key component within agricultural social networks (see Carolan, 2006 *in* Oreszczyn et al., 2010), in addition to the role of both formal and informal social relations (Sligo and Massey, 2007 *in* Oreszczyn et al., 2010). As Sligo and Massey (2007 *in* Oreszczyn et al., 2010) explain, the socio-spatial networks of farmer learning are mediated and contested through interpersonal social networks based

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[7] Giest and Howlett (2014) make the important point that a network leader or manager must be both accountable and flexible in their approach to the network, maintaining dynamism and opportunities for learning (Goldsmith and Eggers, 2004 *in* Giest and Howlett, 2014).

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on trust. A network may be undermined by mistrust or goal incongruence (Giest and Howlett, 2014). The creation of trust and reciprocity within a network is supported by a network leader or facilitator, who organises and directs network management activities for the members (Giest and Howlett, 2014).

In supporting thematic network development, NEFERTITI is not only concerned with gaining a number of members for the network, but ensuring that these members interact and link in new ways. As Giest and Howlett explain:

> *"When network diversity grows, it becomes more visible, which in turn leads to more members that contribute. These arrangements in general improve innovative capabilities, because they expose their members to novel sources of ideas, enabling fast access to resources and enhancing the transfer of knowledge. Face-to-face contacts…make it easier to exchange tacit knowledge and co-create innovative ideas"* (Powell and Grodal, 2005 *in* Giest and Howlett, 2014: 39).

This is described in the literature as the role of the network leader (i.e. the NEFERTITI network leaders and hub coaches), who is tasked with knowledge exchange, overcoming networking obstacles, as well as identifying and including new network members and resources (Giest and Howlett, 2014). Further network responsibilities undertaken by the network leader are summarised as:

- 'Activating' and including the right members;
- Framing the network, including 'establishing the operating rules of the network, shaping its values and norms, including the network participants';
- Mobilisation and adaptability;
- Ensuring productive interaction, through creating and enhancing a conducive network environment; and
- Facilitating critical participant discussion, to achieve "deeper levels of understanding; inquiry and innovation" and producing more 'effective learning' (after Giest and Howlett, 2014: 44).

Sutherland et al. (2017) describe three types of networks and how they link to different knowledge types; this typology is summarised in Table 2. It is anticipated that the NEFERTITI networks will cross the boundaries and encompass all three network types as presented in Table 2, according to network activities and membership.

Table 2 Network and knowledge types

Type of network	Knowledge type (i.e. best transferred by network)
Centralised network: **organised around a central node through which all knowledge flows.**	Codified knowledge; explicit and standardised (e.g. routine problem solving, general regulatory issues).
Distributed network: **dense networks of ties that resemble communities/networks of practice.**	Tacit knowledge; personal knowledge exchanged between peers.
Decentralised networks: **multiple nodal points connect diverse individuals; draw on weak ties.**	Potential knowledge; including knowledge of future innovations transferred by others outside of peer group.

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Furthermore, Brunori and colleagues identify principles of a network that would allow for efficient innovation and to support learning. These principles (and their description) are replicated in Table 3 (Brunori et al., 2013: 16).

Table 3 Network principles after Brunori et al. 2013

Property	Description
Connectivity	Each node has the possibility to link up – directly and indirectly – to a great number of other nodes. In the hierarchical mode, communication with others is strongly restricted.
Interactivity	Communication among nodes is a two ways communication (includes feed-backs or retro-actions). In hierarchical modes, unidirectional communication prevails.
Embeddedness	Each node of the network belongs to multiple networks, allowing the circulation of resources from one network to another. Hierarchical modes 'close' or strictly regulate interaction with the outside.
Diversity	A network form is based on the autonomy of the nodes. Nodes' diversity is then much higher than in hierarchical modes. This diversity increases the flows of resources in the network.
Weak relations	Most of network's relations are not codified, so they are flexible enough to adapt to a changing context.

A concept similar to the network approach adopted by the NEFERTITI project is that of 'communities of practice', i.e. "groups of people who share a common pursuit, activity or concern [and who] do not necessarily work together, but form a common identity and understanding through their common interests and interactions" (Orezczyn et al., 2010: 405). Oreszczyn and colleagues (2010) found that farmers form networks of practice, underpinned by weak organisational frames, and including links with wider networks or communities of practice that may be considered 'influencers of practice' (2010).

As summarised: "Wenger (1998, 2000) identified three aspects of communities of practice that work together and that may enhance learning:

- Mutual engagement: members come together because they are engaged in actions whose meaning they negotiate with one another. They develop shared practices and are linked through their mutual engagement in such activities.
- Joint enterprise: members work together, explicitly or implicitly, to achieve a negotiated common goal, which may or may not be officially defined.
- Shared repertoire: a common history and culture is generated over time by shared practices, stories, tools, concepts and repeated interactions. Writing, routines, rituals, ways of doing things and so on become a common repository." (in Oreszczyn 2010: 405)

The concept of a network or community of practice is helpful for understanding situated learning and knowledge creation by a wide variety of disciplines and practitioners, and it is asserted that participation in a community of practice is essential to practice-based learning (Barston and Tusting, 2005 *in* Oreszczyn et al.,

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2010). Within NEFERTITI, the thematic networks will utilise the demonstration farms of the hub membership as 'geo-referenced' locations for practice-based learning and demonstrating 'best practice'. The NEFERTITI networks are described in the following section.

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3

THE NEFERTITI NETWORKS and KEY FACTORS FOR NETWORK DEVELOPMENT

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The NEFERTITI networks: key factors for network development

The NEFERTITI networks

Demonstration activities on farms are seen as an effective peer-to-peer learning approach. The outreach of the 'demo-farms' is often limited to its regional context. However, when overlooking the EU territories, demonstrations on similar topics are organised all over Europe. The challenge for NEFERTITI is to connect the apparent interest in these topics to create a better knowledge flow throughout the regions, to improve accessibility to the activities and related partners, and to improve exchange over the activities so that through improved information flows, accessibility and networks innovation is boosted. The challenge from the research call thus can be reformulated as: "to develop approaches of sharing that will contribute to learning", because that is what is targeted with sharing knowledge, experience and new approaches.

The NEFERTITI project will facilitate 10 thematic networks, partly cross-sectoral, on key topics pertinent for sustainable and competitive farming, that are on the agenda of practice and policy in animal husbandry, arable and horticultural production. The themes are in line with the priorities drawn by the 'Long-term strategy' of the DGs AGRI/RTD of the EC and particularly fall under the three interlinked 'sustainable primary production' themes targeted in this strategy: Integrated ecological approach from farm to landscape / resource management / healthier plants and livestock. The themes are also closely linked to existing H2020 Thematic Networks, which will support the dissemination and the uptake of the practical-oriented knowledge delivered by EIP cross-border related projects. The ten themes are as follows:

1. Grassland and carbon sequestration
2. Data-driven decisions for dairy farmers
3. Robust organic livestock systems
4. Optimal soil quality in arable crops
5. Arable crop sensing and variable rate applications
6. Increasing productivity and quality in organic arable cropping
7. Improved nutrient use efficiency in horticulture
8. Water use efficiency in horticulture
9. Reducing pesticide use in the production of grapes, fruit and vegetables
10. 'You can farm': Farm attractiveness

The networks are described in the NEFERTITI research proposal as follows:

1. Grassland and Carbon Sequestration

Covering 61 million ha, grasslands are vitally important, representing 16% of the total area and 40% of the European agricultural area. They serve multifunctional purposes with a large acreage exclusively used as animal feed. Production of dairy, beef and sheep is of major economic importance. There is also a large potential for carbon sequestration and mitigation of climate change by conservation of grasslands, which can serve as ecosystem services. Competitive claims on grasslands imposed the importance to create feasible and practicable procedures and best practice recommendations on a mid-term basis. These options should (1) contribute to a reasonable and measurable reduction of greenhouse gas emissions from grassland use; (2) be able to be integrated in a an easy way in conventional grassland farming through minor adaptations to regional water and farming management; (3) enhance sustainability by efficient manure management with reduced N-emissions in water bodies, ecosystem services as a contribution to biodiversity, landscape protection and carbon storage; (4) best be implemented by a common multi-actor network from different responsibilities.

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2. Data driven decisions for dairy farmers

The management challenges that farmers face will include: – reproduction, udder health, lameness, nutrition, data management, milking data, activity and behaviour, metabolic diseases, calves & young stock, land & grassland management and housing. These are the special interest groups in 4D4F that were chosen by the dairy farming community as the most important. The technologies that will be covered by the hubs will include – movement sensors on the neck and on the ankle (for heat detection and general levels of activity), thermal cameras (for body condition score scanning, mastitis detection and hoof disease), temperature sensors (in the ear and the reticulum), pH monitors (in the reticulum), LIDAR (for grass growth), microphones(for rumination and cuddling activity), in-line progesterone sensing in the parlour (for heat detection), sensors on the tail and in the birth canal (to detect calving) and environmental sensors (to manage building ventilation). The hubs demonstrate how these technologies can be used to create data that will improve decision making leading to greater profitability, improved animal welfare and improved environmental performance on the farm.

3. Robust organic livestock systems

The challenge of organic livestock farming is developing sustainable farming systems that rely on smart ecological intensification and meet societal expectations regarding animal health and welfare. The network will bring together farmers who carry out demonstration activities on livestock organic production, as well as facilitators, advisors and scientists involved in those activities. The specific objectives of the network will be to share knowledge and experience around problems and solutions related to animal welfare and health management. Demonstration activities will be focused on new practices or technologies that help reduce the use of antibiotics and anthelmintics, improve animal robustness, welfare and feeding strategies. The second objective is to share knowledge and experience around specificities of demonstration in organic livestock systems that allow engaging conventional farmers, increasing conversions and improving outreach and interaction with consumers.

4. Optimal soil quality in arable crops

The network focusses on demonstration of best practices of soil management in arable crop rotations, including highly mechanized vegetable crops like potatoes and crops grown for the processing industry. The demo-activities concern proven and economical balanced techniques and practices with high potential to improve the agronomic and societal soil services for the short and the long term. Soil services include food security, income, minimal emissions (nutrients, pesticides), carbon storage related to climate change mitigation and adaptation, prevention of soil degradation and erosion and improvement of biodiversity. Techniques and practices for sustainable soil management include diversification of crop rotation including cover crops, mechanization and tillage, application of organic inputs and balanced fertilization, involving also precision agriculture techniques in order to take special variability in soil conditions into account.

5. Crop sensing and variable rate applications

On several demonstration farms, Precision Agriculture applications will be shown, focusing on informing colleague farmers on the added value in economic terms, production quantity and quality, environmental impact, investments needed and user friendliness of the application. The objective of the demonstrations will be to improve the uptake of precision technologies amongst arable farmers and to organize feedback from farmers to research and commercial organizations to increase the uptake and impact of these technologies. Focus will be on main arable crops like potato, wheat and maize. For the selection of suitable applications, the Smart AKIS inventory will be used. The selected applications will be a combination of: (i) Sensing platforms (autonomous or connected to a tractor or implement), (ii) DSS or app (in the cloud) for transforming sensing data into application maps for variable rate applications, and (iii) Actual application of inputs (water, chemicals, fertilizers, lime).

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6. Increasing productivity and quality in organic arable cropping

There is need, but also a clear possibility to improve farm yields in organic arable cropping. The network will promote exchange of knowledge among farmers, farm advisers, and scientists across Europe to foster uptake of solutions that increase productivity and quality in organic arable cropping. The demonstration activities focus on five themes: Soil quality and fertility; Nutrient management; Pest and disease control; Weed management, and Crop-specific challenges. The solutions are scientifically sound, accepted by farmers and embedded in organic farming systems.

Examples include new crop rotations, intercropping with legumes, green manures, new fertilizers, innovative machines for sowing, (minimum) tillage and weed control, soil quality control, use of decision support systems. Solutions are uploaded to the knowledge platform of OK-Net Arable which also provides an opportunity for online exchange with farmers and advisers outside the project.

7. Improved nutrient use efficiency in horticulture

The network will focus on efficiency of nutrient management and fertilisation under horticultural crops (greenhouse grown and open field vegetables, and fruit). Novel approaches for improved fertiliser efficiency (at least NPK) will be demonstrated with mineral and organic fertilizers. Soil or drain laboratory analyses will be combined with sensor-based approaches such as Geographic Information System (GIS). Crop rotation and sources of available nutrients, distinct from fertiliser, will be included. For conventional fertilisation, the focus will be on a) Decision Support Systems (DSS) that calculate daily fertiliser requirements and b) fertilisation based on sensing/monitoring. For organic fertilisation, the demonstrated techniques include the integrated cultivation of crop plant between, respectively in the fruit tree rows in existing orchards as well as using of different cover crops before planting new orchards and best application of special manure spreaders and compost.

8. Water use efficiency in horticulture

Irrigation is used throughout the EU on 23 Mha and represents 30% of EU water use, being 80% in drier countries. Appreciably improved water use in horticulture is required because of competing demands for limited water supplies and the need to minimise degradation of water resources through overexploitation, and addition of nutrients and plant protection products (PPPs). For objective 1, two integrated approaches will be demonstrated: (1) determination of crop water requirements using farmer-friendly Decision Support Systems and (2) monitoring approaches e.g. soil sensors, remote sensing. For objective 2, three approaches will be demonstrated: (1) outdoor soilless and/or semi protected cropping systems, (2) Zero Liquid Discharge from soilless greenhouse crop, and (3) removal of nutrients and PPPs from discharge water. For both objectives, procedures to improve supply water quality and the use of different water sources will be demonstrated e.g. water collection from greenhouse roofs and outdoor basins, and reuse of urban water.

9. Pesticide use reduction in the production of grapes, fruits and vegetables

Even if treatments are sometimes necessary, solutions for reducing the use of chemical pesticides, diminishing the impact on human health and environment, exist. Besides, proposing new models of IPM and advanced organic production need to take into account some different approaches: (i) efficiency in the pest control; (ii) economy balance and competitiveness, (iii) social and organizational barriers; and (iv) strategies to the implementation. Technically, the focus will be on 1) monitoring approaches (sensors and mathematical models); 2) organic or biocontrol products in adapted strategies; 3) resistant varieties for the main diseases; 4) prophylaxis methods; 5) quality of spray; and 6) organizational design and mechanisms put in place to ensure efficient and effective information flows and exchanges between end users. Different methods will be combined for the same crop.

10. You can Farm: Farm attractivity for new entrants

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Build a network of demonstration farms that promote an attractive career and working environment for their own contexts to young farmers, students, their parents, teachers and other interested persons. The network hubs will include demonstration farmer members that may also be involved in other demonstration farm networks but who specifically offer their farms and time for the support and formation of young people and early career farmers. The network will have members who promote a safe working environment with sustainability and quality of life benchmarks as well as technical, quality and economic performance indicators. These farmers also have a passion for what they do and an ability to motivate and culture the interest of younger minds towards the career possibilities. It will be particularly attractive to farmers who open their farms for visits, skills demonstrations, innovation updates and social learning. It will help to demonstrate alternative ways to become a farmer and newer career paths to be involved in farming both full and part time. New organisational structures like partnerships and share farming will be promoted, as well as traditional family farming.

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Key factors in network development

To provide guidance for the NEFERTITI hub coaches and network leaders, the academic and practitioner literature was reviewed to identify the key factors in network development. Based on the literature review, the NEFERTITI project proposes the following key factors for innovative network establishment (Figure 3): (i) clarifying network purpose, identity, and values; (ii) network recruitment and governance; (iii) knowledge exchange and learning activities for value creation; (iv) network infrastructure and resources; (v) network monitoring and evaluation; as well as (vi) network maintenance.

In the NEFERTITI project, a distinction is made between two hierarchical levels: hubs at the regional/national level and networks at EU level. A hub is a group of demonstration farms working on a given topic or challenge, who are connected through relevant innovation actors (e.g., farmers, advisors, education, NGOs, researchers, industry and managing authorities). Hubs should be developed as much as possible based on already existing national and regional networks of demo-farms or other relevant groups, added with demo-farms inventoried during the FarmDemo H2020 project. A NEFERTITI network is defined as the connection between several regional/national hubs and innovation actors working on the same topic/challenge. They bring together hubs, Operational Groups, existing EIP Thematic Networks, study groups and other bottom-up networks of farming communities working on the selected themes in Europe.

These 'Key Factors in Network Development' (also available as a separate NEFERTITI project document for practitioners) are described below and aim to support network creation and success on the part of the NEFERTITI network leaders and hub coaches. They will be used throughout the NEFERTITI project and aim to help network and hub leaders in establishing and maintaining their respective network or hub, through raising awareness and understanding regarding the key factors. They will be used as a backbone for the dynamic action plans and monitoring approaches.
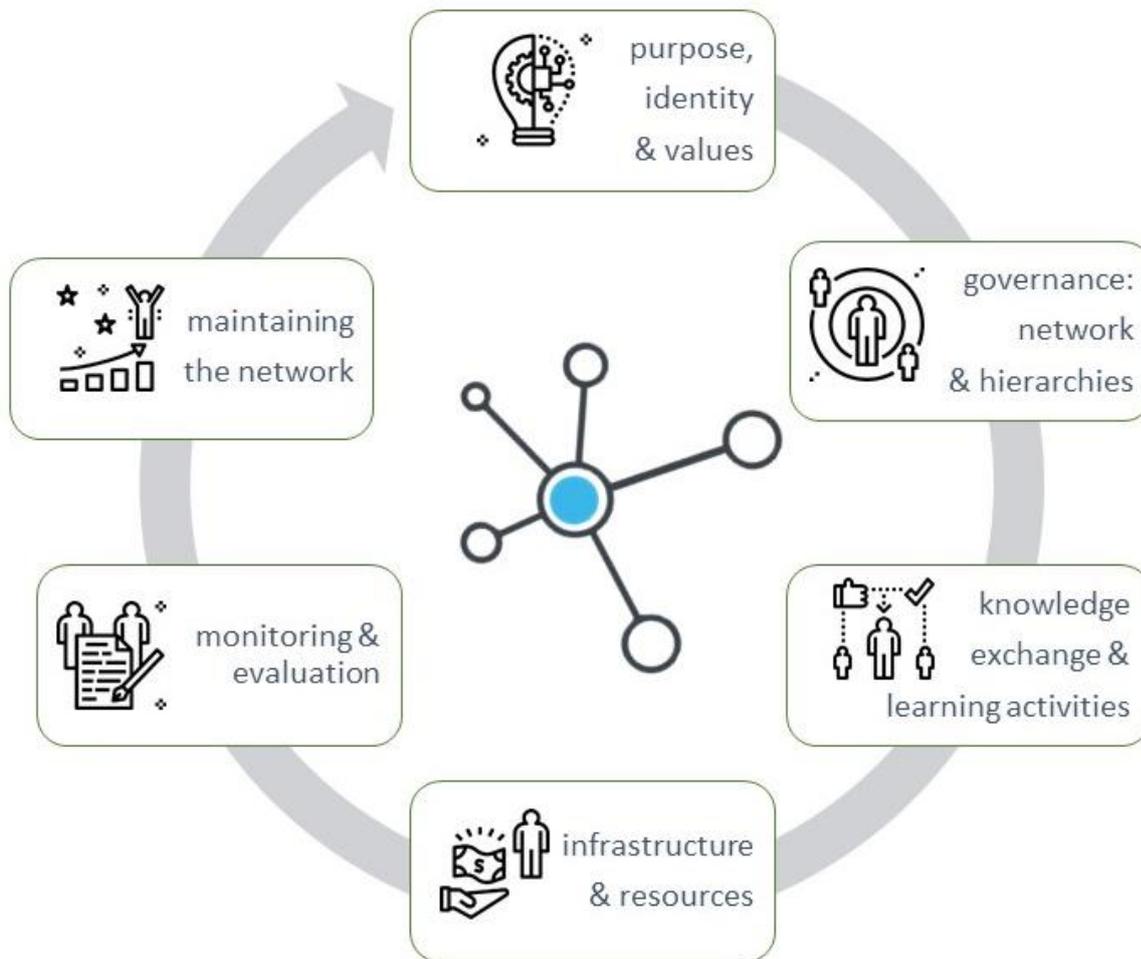
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Figure 3. Overview of key factors for successful network development

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1. *Network purpose, identity and values*

> ➢ *A network enables the flow of resources including knowledge and innovative techniques through a system of relations and connections between individuals.*
> ➢ *The purpose of a network may be summarised as a shared vision to which network members can subscribe.*
> ➢ *The network culture encapsulates the implicit and explicit values prevalent in a network, which can underpin the relationships within the network.*
>
> ➢ *The purpose of network creation in the NEFERTITI project is to facilitate peer-to-peer learning between demonstration farms, and to support innovation and sustainable agricultural practice.*
> ➢ *Each NEFERTITI network should consider its purpose and the motivation (i.e. autonomous or controlled) of members to join and remain in the network.*

The aim of a network is to enable the flow of resources including knowledge and innovative techniques through a system of relations and connections between individuals. In the NEFERTITI project, network creation is for the purpose of facilitating peer-to-peer learning between demonstration farms, in order to support innovation and sustainable agricultural practice.

The purpose of a network may be summarised as a shared vision to which network members can subscribe. Three questions can guide the drafting of a network purpose[8]: Who is the network for? What problem is the network working on? What type of collaborative activities will the network undertake? The purpose is not aimed at creating universal agreement among members' viewpoints, but rather to state, clearly and unambiguously, what is the reason for the existence of the network. It "*creates an identity around a common agenda or area for learning*" (Wenger, Trayner, and de Laat, 2011, p. 12). When the network's purpose is clear, it can then be easier to determine the motivations of individuals or organisations, and therefore their reasons for joining and engaging in the network[8]. In the NEFERTITI project, the overall purpose of the networks is to connect and network existing demo-farms and innovation actors in specific themes within Europe, in order to boost interactive innovation approaches and projects. This is realized by the flow of knowledge and innovation techniques through a system of relations and connections between individuals.

Once a network's purpose is clear, it is useful to think about why people might want to join, or their motivations for engaging in the network. Knowing the motivation of members is useful to better design and plan your network, because it provides information on commonalities between network members[1]. Motivation or reasons to participate in a network can be classified in different ways. An interesting distinction is that between autonomous and controlled motivation (Dedeurwaerdere *et al.*, 2016; Ryan and Deci, 2000). Autonomous motivation reflects personal endorsement and a feeling of choice or even joy to participate and engage. Controlled motivation reflects compliance with external controls, such as (peer) pressure or rewards. According to self-determination theory, autonomous motivation is associated with greater persistence, performance and social functioning compared to controlled motivation (Vansteenkiste *et al.* 2010). However, external controls

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[8] Source: 'Unlocking Networks' handbook: 'Identity, Purpose and Values', available online: www.unlockingnetworks.org; last updated: 2018; accessed: 28.5.18.

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might help to nudge people to participate in a network (Triste *et al.*, 2018; Mills *et al.*, 2016). Controlling factors can be incorporated into the self and eventually result in autonomous motivation when the right conditions are created within the network (Vansteenkiste *et al.* 2010).

Such conditions can be created through the "network culture". The network culture represents both the implicit or the explicit values that are prevalent in a network[8]. These values can concern how you want the network members to treat each other, or how you want the network to be acknowledged by actors external to the network[8].

2. *Governance: network formation and hierarchies*

> ➢ *Networks are formed through the facilitation of linkages between cooperative partners.*
> ➢ *Network members may be suited to different roles – an important consideration for network recruitment and establishing members' value to creating a resilient network.*
> ➢ *Governance of the network is also about decision-making; it is important to make and implement decisions that enable and empower network members.*
> ➢ *In NEFERTITI, two levels of networks are distinguished: (i) hubs at the regional/national level and (ii) networks at the EU level.*
> ➢ *A NEFERTITI network is defined as the connection between several regional /national hubs and innovation actors working on the same challenge (i.e. network theme).*

Network formation involves the "facilitation of linkages between relevant actors" (Klerkx and Leeuwis, 2009: 851), and therefore the "scanning, scoping, filtering, and match-matching of possible cooperation partners" (Klerkx and Leeuwis, 2009: 851). Building trusting relationships is central to this stage of network establishment.

In networks, people can have different roles. It is interesting to think about the important roles that need to be performed in the network, also regarding the recruitment of people in the governing bodies of the network. Further, establishing clear roles for network members, making their value clear from the start, contributes to a resilient network and to value creation in the network (see key factor 3). Roles can be defined in different ways. First, they can be defined based on the quantity and quality of their relations to other people and organizations. Using this definition, we distinguish: (i) people who are well socially connected and are thus effective information-spreaders in the network, (ii) people who hold critical connections with organizations or people, (iii) people who connect two or more clusters, (iv) people who are loosely connected to the network, but provide important expertise, or (v) people who broadcast information outside their group. Second, roles can be defined based on the function or activities they carry out in the network[9]. A distinction can be made between: (i) network connectors, who identify and strengthen underdeveloped aspects of the network, (ii) project coordinators who catalyse and coordinate teams on collaborative projects, e.g. specific demonstrations or activities, (iii) network facilitators who help groups of people to come together and set up a formal network, help coordinating actions,

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[9] Source: 'Unlocking Networks' handbook: 'Roles of people in networks', available online:
www.unlockingnetworks.org; last updated: 2018; accessed: 29.5.18.

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and ensures resilient relationships, (iv) network guardians, who oversee what the network needs to function more effectively; and finally (v) network funders[9].

Network governance is also about decision-making. There are many different ways of making decisions in groups, and it may be that some ways suit your members better than others. For example, the AgriDemo analytical framework (Koutsouris *et al.,* 2017) mentions that many models exist to organise the governance of demonstration programmes, networks and activities and related policies, but that participatory, collaborative, multi-level and co-governance models that aim to empower farmers' engagement, may contribute definitively to effective demonstration programs. Four questions can guide the thinking about establishing a decision-making process within a network[10]:

- Who cares? Involve only those people who genuinely wants to be involved in decision making and those who will be affected by the decision-making.

- Who knows? Encourage the people who have the expertise you need in the decision-making.

- Who must agree? Involve those people whose cooperation you might need in the form of authority of influence.

- How many people is it worth involving? Involve the fewest number of people while still considering the quality of the decision along with the support people give it.

This means that the people involved in the decision-making can differ according to the topic that has to be decided upon. However, it is important to make and implement decisions that enable network members[10].

Furthermore, it is important that the network is able and willing to adapt and make decisions that take into account different perspectives, changing conditions and shift in the context in which the network is embedded. Developing network resilience is described in key factor 6. We advise that a diverse group of innovation actors are recruited, to ensure network vibrancy and to increase innovation[9].

Within the NEFERTITI-project different governing bodies are defined. For the hubs, a hub board is responsible for setting up the hub, developing the annual demo-campaign and proposing ideas for network activities. The hub board (4-6 people) consists of a hub coach, a deputy coach, farmers and advisors or other innovation actors. Hub members are all other relevant innovation actors (10-15 people). For the networks, we distinguish an operational unit and a support unit. The operational unit (4-7 people) consists of a network leader, a deputy leader and other hub coaches and is responsible for setting up the network, establishing the support unit of innovation actors, plan network activities and develop dynamic action plans. The support unit of a network consists of all members of the operational unit, Operational Groups, EIP Thematic Networks, other networks of farming communities, and other European innovation actors. Its role is to contribute to setting up the network, developing the dynamic action plan and implement the network's activities.

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[10] Source: 'Unlocking Networks' handbook: 'Power and decision-making', available online: www.unlockingnetworks.org; last updated: 2018; accessed: 29.5.18.

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3. Knowledge exchange and learning activities for value creation

> ➢ *Value creation, i.e. the development of good practice and capacity building, is an important element of network creation, recruitment and retaining membership.*
>
> ➢ *NEFERTITI distinguishes between how to set up farm demonstrations to stimulate innovation uptake and the development of good practice around the network theme.*
>
> ➢ *NEFERTITI networks can support value creation by providing space for interactive learning through dialogue, debate, questioning and reflection during network activities, and 'learning-by-doing' through the organisation of demonstration activities.*
>
> ➢ *The project will design and implement appropriate mediation techniques and communication tools to support network knowledge exchange.*

Value creation is an important aspect of a network, because without shared values, people will not join or stay involved in the network. Value creation refers to the development of good practice and capacity building necessary for network development[11]. Networks can provide many kinds of value. For example, Wenger *et al.* (2011) distinquish between **immediate value,** referring to the network activities as having value of themselves, **potential value,** referring to knowledge capital that might be of use later, **applied value,** referring to adoption and application of learned knowledge, **realized value,** referring to the successes of the applied knowledge, and **reframing value**, referring to changed understandings, strategies or goals and changes in the definition of what matters.

An interesting dual purpose arises in types of value created in the NEFERTITI networks, i.e. the distinction between (i) the development of good practice and capacity building around how to set up demonstrations to stimulate innovation uptake, and (ii) the development of good practices and capacity building on the respective network themes (e.g., grassland and carbon sequestration, data driven decisions for dairy farmers, etc.). The first will be mainly of value for the members of the NEFERTITI networks and hubs and other stakeholders involved with demonstration activities, while the latter will be mainly of value for participants of the demonstration activities. Both types of output should be taken into account at all times in the NEFERTITI networks.

Building capacity and developing good practice is supported by the network activities through:

- benchmarking (comparing what you do with what others do);

- discovering new solutions or tools for commonly experienced problems;

- creating sector insights by keeping up-to-speed on the latest news;

- the motivational source of group dynamics to excel people in what they do;

- constructive criticism from peers to strengthen one's skills[4].

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[11] Source: 'Unlocking Networks' handbook, available online: www.unlockingnetworks.org; last updated: 2018; accessed: 28.5.18.

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Furthermore, according to the AgriDemo project (Koutsouris *et al.,* 2017), when designing the annual 'demo-campaigns', the NEFERTITI networks can support this value creation by focussing on the following processes: (i) providing a space for interactive learning through dialogue, debate, questioning and reflection during network activities, (ii) providing a space for learning from experience and learning by doing through the organisation of demonstration activities, (iii) taking into account the variation of learning capacities and contexts of networks members and demonstration participants, (iv) facilitating interaction and learning through the formalisation and organisation of the learning environment and processes, and through managing critical discussions among members and participants, (v) designing and implementing appropriate mediation techniques and communication tools, such as instructional videos and blogs (and others).

While organizing activities for value creation, network members and facilitators might be confronted with challenges. It is important to be aware of these potential challenges when governing a network. Challenges that are often identified by other practitioners are[4]: time constraints of members, cost/benefit ratio, people withholding information because of professional or commercial reasons, engaging long-standing members who feel they get less out of the network than newer members, group cohesion when highly influential or well-connected members leave the network, group thinking about a set of practices that leaves little space for innovation or new solutions, and concentration of power and resources.

4. *Infrastructure and resources*

> ➢ *Establishing and maintaining a network requires resources, assets or 'capitals': natural, cultural, human, social, political, financial, and built.*
> ➢ *Network leaders require leadership capacity, plus access to outside resources such as communication tools or other bodies of knowledge/data that can support developing, understanding and identifying good practice.*
> ➢ *Social capital (i.e. the connections between people and organisations), including 'bridging' and 'bonding' capital, is a key component of network formation and the transfer of tacit, practical knowledge.*

The NEFERTITI project aims to establish an EU-wide highly connected network of well-specified demonstration and pilot farms, and is designed to enhance thematic knowledge exchanges, cross fertilisation among actors and efficient innovation uptake in the farming sector through peer-to-peer demonstration of techniques.

Firstly, to identify good practice and to build capacity in the organization of demo-activities, the NEFERTITI project foresees actions that (i) support evaluation of demo-activities, and (ii) support the exchange of knowledge and experiences among demonstration farms and innovation actors, and foster cross-fertilization between different sectors and themes in Europe. Second, to foster good practice and capacity building within the network themes, the demonstration activities organized by the hubs will be the main source of information. In order to undertake these activities, the network leaders and hub coaches within the NEFERTITI project require resources, assets, and infrastructure.

The framework of 'community capitals' captures the types of resources that are necessary for establishing and maintaining the networks. These capitals are: **natural** (i.e. the assets of a particular location, including natural resources and landscape); **cultural** (i.e. traditions and language); **human** (i.e. the skills and abilities of people);

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social (i.e. the connections between people and organisations); **political** (i.e. access to power-brokers; empowerment to engage in activities); **financial** (i.e. the financial resources available to invest in capacity building and future development); and **built** (i.e. the infrastructure supporting these activities) (Emery and Flora, 2006). As they are of major importance within the networks and activities of the NEFERTITI project, we focus on human and social capital. For human capital in particular for instance, key is the ability of network leadership to: "lead across differences", to focus on assets, to be inclusive and participatory, and to act proactively in shaping the future of the community or group (Becker, 1964; Flora *et al.*, 2004 in Emery and Flora, 2006: 21). In order to support this inclusive approach, the network leaders may rely on access to outside resources such as communication tools or other bodies of knowledge/data that can support developing understanding and identifying good practice (Emery and Flora, 2006). The NEFERTITI project aims to create knowledge banks on the project's online platform, to compile the available knowledge arising from the network themes.

Social capital, including 'bridging' and 'bonding' capital, is also a key component of network formation and the transfer of tacit, practical knowledge (cf. Granovetter, 1973 in Sutherland *et al.*, 2017). Furthermore, entrepreneurial social capital is characterised by internal and external networks, as well as the mobilisation of local resources and seeking alternative routes to key outcomes. These concepts are central to the NEFERTITI project.

With regard to financial capital, the NEFERTITI project will provide a budget for both hubs and networks. Details of this budget allocation can be found in the documents: 'Guidelines on how to set up a network' and 'Guideline on how to set up a hub'.

5. *Network monitoring and evaluation*

> ➢ *To find out if and why a network works, monitoring and evaluation are of key importance.*
> ➢ *Specific assessment tools and knowledge exchange can aid the development of knowledge on demonstration activities.*
> ➢
> ➢ *Within NEFERTITI, monitoring and evaluation serves both the purpose of effectively developing the NEFERTITI networks and of increasing the impact of demonstration activities.*
> ➢ *The Dynamic Action Plan (DAP) will aid to systematically reflect on the networks structure and management, by questioning its goals, challenges and actions.*

It is often difficult to directly pinpoint if and why a network works. There are different reasons to evaluate or monitor a network, such as examining whether the network achieves results and impact, determining the return on investment, to find areas of improvement and enable learning, or inform strategy and vision for the future[12].

Different types of data can be used to evaluate activities: quantitative data (e.g. number of members or participants), and qualitative data (e.g. discussions, interviews, observations)[12]. However, the use of both types of data often contribute to a richer picture of what people want to measure (Wenger *et al.*, 2011). For example, the number of participants can give you an idea of the level of interest in the network, but qualitative data can also give insights on why they participate. Furthermore, the comparison of sets of data throughout time, can

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[12] Source: 'Unlocking Networks' handbook: 'Measuring impact', available online: www.unlockingnetworks.org; last updated: 2018; accessed: 31.5.18.

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provide information on how and why things change. Often proxies will be used to measure specific effects (Wenger *et al.*, 2011). For example, when a high number of farmers are present on a demonstration to which participation is free and voluntary, one can assume that the program of the demonstration activity highly appeals to farmers, without knowing more about the actual motivation of farmers to participate. It is useful to think about by whom and when these data should be provided. Further, it is also important to make sure that the network members responsible for data provision are aware of and acknowledge the importance of monitoring and evaluating activities, as it will stimulate them to provide correct and more detailed information. Afterwards, the network should think about how to implement the insights gained in the network structure, management and activities. This phase is interlinked with the governance of and the way decisions are made within the network (see key factor 2).

Within NEFERTITI, network monitoring and evaluation serves two main purposes: the effective development of the ten NEFERTITI networks and to learn on how to increase the impact of demonstration activities.

First, regarding the effective development of the networks, some researchers argue that system innovation networks, as in NEFERTITI, must reflect *"on the challenging and change of presumptions, current practices, and the underlying institutions"* both regarding their structure and their management (van Mierlo *et al.,* 2010: 145). Network members should *"reflexively monitor their own practices, presumptions, and roles, as well as the way they monitor and evaluate"* (van Mierlo *et al.,* 2010: 145). This requires appropriate tools that supports and maintains this reflexivity. In the NEFERTITI project, we will make use of the Dynamic Action Plan[13] (DAP), which allows networks and hubs to continuously reflect on the goals, challenges and actions to be performed.

Second, regarding our insights on the impact of demonstration activities, activities of the NEFERTITI demonstration networks should not only lead to learning on or about standard problem-solving techniques (first order learning), but should also strive for more in-depth transformative learning. This makes learning a complex process which necessitates a careful monitoring of what takes place at demo-farms when farmers share experiences. Monitoring and evaluation of innovation networks is often difficult because good and measurable evaluation indicators are missing, specifically since besides hard measurable criteria, also softer outcomes that are difficult to measure are of relevance (Hermans, Klerkx, and Roep, 2015). Therefore, in the NEFERTITI project specific assessment and evaluation tools will be developed, demo-activities will be observed and assessed, and knowledge exchange between networks will be organized.

To conclude, the M&E (monitoring and evaluation) two step approach will contain i) a general M&E approach to guide NEFERTITI network leaders and hub coaches and ii) very practical M&E manuals. The general M&E approach will be rooted in scientific insights and will address the requirements of the NEFERTITI project. In a second step, very practical 'M&E manuals' will be developed and aim at monitoring demonstration activities and their effectiveness.

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[13] See Dynamic Action Plan- Template

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6. *Maintaining the network*

> ➢ *During the project, networks can undertake actions to ensure the ongoing existence of the network after the project ends.*
> ➢ *Embedding of the network within its wider context (e.g. AKIS), through stakeholder involvement and representation within governing bodies of the network can contribute to this maintained existence.*
> ➢ *Create ownership of the network with the network members, by involving them in decision making during the course of the project, so they will be willing to also engage after NEFERTITI ends.*
> ➢ *Frequently communicate towards policy makers and other stakeholders about the contributions and overall value of the network, to increase the chance to find funders for network both during and after NEFERTITI ends.*

The networks formed within the NEFERTITI project will seek to become resilient and sustainable during the project, in order to ensure that they continue after the project ends (January 2021). This role is undertaken specifically by Tasks 2.6 and WP 6. The concepts of 'resilience' and 'sustainability' can help the network leaders to embed principles and undertake actions that will support the ongoing existence of the network. Furthermore, this key factor is underpinned by principles of communication and good governance, to ensure that the network activities and knowledge are disseminated, building impact and opportunities for future funding.

Social scientists have defined the concept of resilience as 'the capacity of a social system (i.e. a community and network) to proactively adapt to and recover from disturbances' (Comfort *et al.*, 2010, p. 9). Magis (2010) states that community resilience is about the existence of resources, development, and engagement; therefore, two key actions are suggested. Firstly, it is important to create a sense of ownership of the network by the network members, by involving them in decision-making throughout the NEFERTITI project (see also key factor 2). The aim is to foster their connection and ongoing wish to retain the values of the network after NEFERTITI comes to an end.

A second key action in ensuring network resilience and sustainability is the interaction with key stakeholder groups. Triste (2018) shows that to effectively involve stakeholders in a network, it is important that this happens at the initiation of a network, when shared visions and goals for the initiative are starting to be developed. Furthermore, the involvement of stakeholders who are financially strong can contribute to the network's self-sufficiency and reduced reliance of external financing. Embedding the network within a wider context (e.g. AKIS), through the connections of participating stakeholder bodies, and their representation within the governing bodies of the network can contribute to network maintenance, and ongoing legacy.

Furthermore, it is important to use this wider body of network stakeholder to communicate learning from the activities of NEFERTITI networks to policy-makers and other stakeholders. This will seek to share knowledge and understanding developed as a result of the project, the contribution of the NEFERTITI networks to innovation and sustainability of on-farm demonstrations, and the capacity to add value for the network members. Finally, a focus on communicating the project initiatives and outcomes to key stakeholders can support the chance to find funders for ongoing network activities after NEFERTITI ends.

Figure 4. CONCEPTUAL Framework: overview of the important concepts for NEFERTITI network development
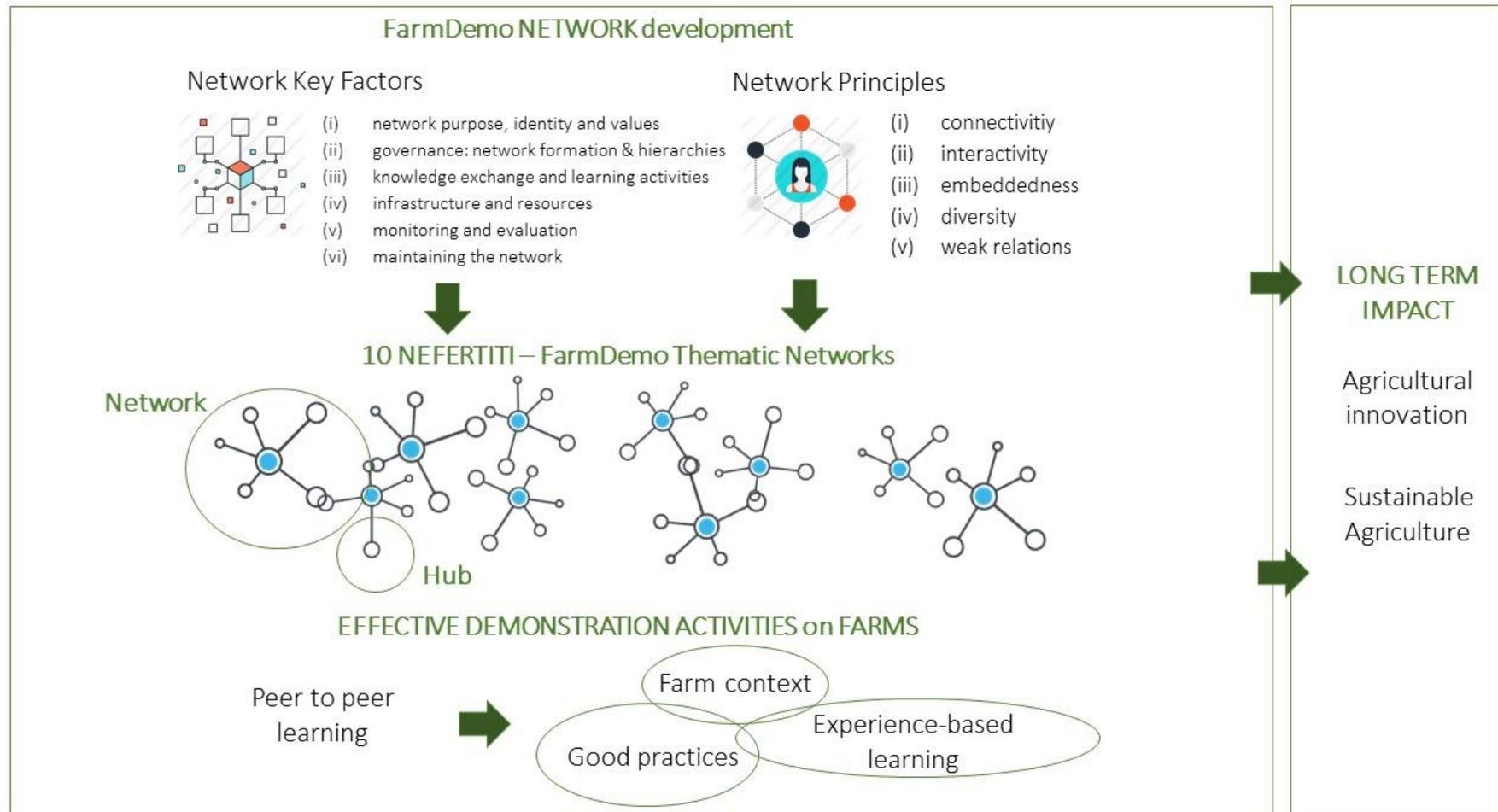
4

GLOSSARY

4. Glossary of key terms

AKIS (Agricultural Knowledge and Innovation System): the collection of agricultural information providers, the flows of information between them, and the institutions regulating these relations. Alternative acronyms AKS and AIS are sometimes used to refer to variations of this definition (AgriLink conceptual framework).

Demonstration farms: educational centres for experience-based learning that promote the practical viability of new or improved farm management practices and technologies through seeing and discussing. They place a particular focus on understanding innovation within a working farm context, within a local setting and across the different stakeholder groups involved. While they focus on the demonstration of known "best" or "good" practices, experimental work may also be conducted, particularly in a learning-by-experiment context (PLAID conceptual framework, Burton, 2017).

Dynamic Action Plan: a structured approach to think of how to develop a NEFERTITI network and a straightforward plan defining concrete actions. It helps to define the networks' goals and identify the challenges towards reaching these goals. It should be used as an action plan in which actions are defined with expected results, responsibilities and timing, so that it represents a basis for ongoing monitoring and later evaluation of the network.

European Innovation Partnership "Promoting Productivity and Sustainability" (EIP-Agri): A European Commission-funded initiative to support interactive innovation in the agricultural and forestry sectors that 'achieves more from less' input and works in harmony with the environment. It is one of five EIPs implemented in Europe (AgriLink conceptual framework).

Hub: organised at regional or national level, a hub is a group of several demo-farms working on a given topic/challenge (crossroad of a sector and theme) and connected to all relevant AKIS actors and stakeholders (R&I, farming sector, education, industry, cooperatives, SMEs, etc.) and their facilities.

Hub coach: a project partner managing the hubs' activities. The coach connects all relevant AKIS actors and stakeholders around the hub in order to boost knowledge exchange and cross-fertilisation around demonstrations. The coach is connected to the other hubs' coaches of the same network and also of other NEFERTITI networks.

Innovation: the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations. Innovation activities are all scientific, technological, organisational, financial and commercial steps which actually, or are intended to, lead to the implementation of innovations (OECD 2009). Examples of innovations promoted by the EIP Agri include technological breakthroughs, new processes and business models, non-technological innovation and innovation in the services sector (Sutherland et al., 2018).

Knowledge reservoir: a web-based platform established specifically for the NEFERTITI project that brings together all information on the participating EU demonstration farms and actors, shares audio visual material created from the demonstration farms to share technical content and to highlight best practices in organising demonstration activities. The web-based network facility collates all content generated over the 10 themes, including written material, brochures, flyers, articles, etc., will be shared on the platform.

Learning process: an outside/inside dynamic both at individual and at collective/organization level, where it is possible to distinguish between learning in the sense of absorbing existing knowledge from others and learning in the sense of discovery or invention (Moschitz and Home, 2012). In NEFERTITI, a monitoring and evaluation approach is developed that enables self-reflection on demo activities in the group of involved actors and supports cross demo and network learning processes. Learning on how effective demonstrations are organised and specifically learning on how to enhance network connectivity, group learning and peer to peer learning is sought.

Multi-actor: NEFERTITI adopts a multi-actor approach, involving as project partners a wide range of relevant actors to achieve the topic objectives (farmers networks, advisory services, applied research, academia, ESIF managing authorities, NGOs, industry, SMEs) from the early initial concept of the

project to the operational implementation of the project. Each partner has a clear role in the project in order to ensure complementarities as well as synergies among partners.

Peer-to-peer learning: Farmers tend to be most influenced by proof of successful farming methods by their peers. The starting point for NEFERTITI is that on-farm demonstration plays an important role in farmer-to-farmer learning and the effective transfer of farming best practice and innovative technologies.

Network: organised at EU level, a network connects several regional/national hubs. Each thematic network thus constitutes a cross-border multi-actor interactive network of demonstration farms and the AKIS actors from several EU countries working on the same topic/challenge and exchanging practical oriented knowledge, farm best-practices, and relevant innovations.

Network leader: a coach managing the network activities. They will harvest ready-to-use material and knowledge from relevant EU projects, organise concrete knowledge exchange activities within the network (knowledge virtual and face-to-face meeting, field cross-visits, etc.), and are responsible for cross-fertilisation with the other NEFERTITI networks.

Operational Groups: a group of people who come together to work on concrete, practical solutions to a problem or innovative opportunity and whose project is funded by the EU Rural Development Policy. An Operational Group consists of several partners with a common interest in a specific, practical innovation project and the people involved in the Operational Group should be from a diverse combination of practical and scientific backgrounds (EIP AGRI).

Sustainable development: development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987).

Thematic network: cross-sectoral and EU wide networks focused on key topics that are pertinent for sustainable and competitive farming. In particular, the themes are aligned with the priorities drawn by the 'Long-term strategy' of the DGs AGRI/RTD of the EC and particularly fall under the three interlinked 'sustainable primary production' themes targeted in this strategy: Integrated ecological approach from farm to landscape / Resource management / Healthier plants and Livestock. Themes are also closely linked to existing H2020 Thematic Networks; this will support the dissemination and the uptake of the practical-oriented knowledge delivered by EIP cross-border related projects. Themes can be adjusted during the project upon identified stakeholder needs.

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Related documents from the NEFERTITI project

Guidelines on how to set up a hub

Guidelines on how to set up a network

Dynamic Action Plan -Template

Key Factors in Network Development

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