On-farm demonstration: enabling peer-to-peer learning

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1. Introduction

By means of its policy and supportive tools, the European Commission has undertaken numerous initiatives to increase the innovativeness of the agricultural sector, with the overall aim of making Europe’s farms more competitive, environmentally sustainable and socially responsible (European Commission 2019). Recognising the importance of learning processes to innovation, in the past decade the European Commission commissioned a series of projects addressing agricultural knowledge and innovation systems (AKIS): Solinsa (Moschitz et al. 2015); FarmPath (Sutherland et al. 2015); PROAKIS (Knierim et al. 2017); AgriSpin (Koutsouris and Zacosta 2020); Agrilink (Labarthe et al. 2018); and I2 Connect. This special issue presents recent European Commission-funded research into on-farm demonstration, undertaken through the Horizon 2020 PLAID (Peer-to-peer learning: Accessing innovation through demonstration), Agri-Demo-F2F (building an interactive agri-demo-hub community: enhancing peer-to-peer learning), and NEFERTITI (Networking European Farms to Enhance Cross Fertilisation and Innovation Uptake through Demonstration) projects, jointly branded ‘FarmDemo’.

The European Commission (2014, 3) defines a demonstration project/activity as a:

practical session to illustrate a technology, the use of new or significantly improved machinery, a new crop protection method or a specific production technique. The activity can take place in a farm or in other places such as research centres, exhibition buildings, etc.

These on-farm demonstrations are supported by a dedicated sub-measure for ‘Demonstration projects and information actions’, within Member States’ Rural Development Programmes (2014–2020). Demonstration activities can be organised on many farm types, such as experimental or research farms, farms owned by trusts and charitable organisations, and commercial farms. Demonstration activities are organised by farmers, private companies, farmers’ organisations, NGOs, extension services, research institutes and/or public institutions in many different coalitions. 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 (Prager and Creaney 2017); to permanent ‘research farms’ where researchers test and demonstrate cutting edge technologies and approaches. Increasingly, farmers themselves are opening their farms for engagement with their peers and the general public as part of business development strategies (e.g. short food supply chains, community-supported agriculture), using traditional and new virtual ‘on-line’ methods. On-farm demonstration is thus one activity – amongst many – embedded in AKIS and mobilised by AKIS actors to facilitate farmer learning.

The concept of AKIS (as ‘agricultural knowledge and information systems’) was developed in the late 1980s, recognising that farmers engage with a number of sources (including research, agricultural advisors, and education/training and support services) to exchange knowledge (Röling and Wagemakers 1998). The approach thus updated the established linear model of technology transfer, promoting an interactive model of networking systems, which integrate knowledge production, adaptation, advice and education (EU SCAR 2012; Klerkx, Van Mierlo, and Leeuwis 2012). The AKIS concept recognised that farmers do not primarily learn in isolation, or in linear relationships with extension agents. Instead, new learning and innovation creation was recognised as resulting from iterative engagement in non-linear knowledge networks or systems (Chambers, Pacey, and Thrupp 1989; van Crowder and Andersen 1997; Dockès, Tisenkopfs, and Bock 2011; Röling and Wagemakers 1998).

The AKIS concept has gained considerable profile in European policy in the twenty-first century, re-termed ‘agricultural knowledge and innovation systems’ (EU SCAR 2012; Klerkx, Van Mierlo, and Leeuwis 2012), demonstrating the importance placed on innovation by recent EU policies. The new definition also identifies the importance of a variety of up- and downstream actors (e.g. supply chain members, charities, accountants) for innovation in the agricultural sector (Hall et al. 2006). At EU level, EIP-AGRI Operational Groups, within the Rural Development Programmes (RDP) and Multi-Actor H2020 Thematic Network projects across EU member states, also focus on peer learning. Peer learning knowledge exchange initiatives are supported at national level through a range of approaches, such as Farmer Field Labs and Monitor Farms in the UK.

Outside Europe, similar evolutionary processes have been on-going for more than three decades: examples include the lead farmers approach in African countries (DAES 2015), the well-known Farmer Field Schools and more recently the lighthouse farms network established by Wageningen University. The Farmer Field Schools (FFS), originated in the FOA Regional Rice Integrated Pest Management Program for South and Southeast Asia, were developed as an alternative paradigm to the ‘transfer of technology’ approach (Röling 2002). The concepts of learning and farmer empowerment reflected theories of Paolo Freire (1968), David Kolb (1984) and Jurgen Habermas (1971). FFS implement a practical approach building on local knowledge systems, learn in groups, and use field-based hands-on learning to empower farmers (van den Berg et al. 2021). The experiences and innovative ideas of Kenmore, Gallagher and Dilts led to the development of the farmer field school concept, first implemented in 1989 and spread over 90 countries worldwide (FAO 2019). More recently, the lighthouse farm network, established by Wageningen University & Research (WUR), consists of a mosaic of customised farming systems, for contrasting environments, climates, farmers and cultures. This network of lighthouses from all over the world is intended to create a uniquely tangible ‘real-life’ global outdoor classroom and laboratory on sustainable food security.
Within these initiatives and networks, demonstration farms have a major role to play in the application of scientific findings (science-driven research) and the spreading of best practices and innovative farming approaches (innovation-driven research) within farming communities (Koutsouris et al. 2017).

In this special issue, we focus on the demonstrations held on commercial farms, drawing particular attention to mechanisms of peer-to-peer learning. Although on-farm demonstration is a well-established method of agricultural extension, there is very little in the academic or grey literatures about the approaches, effectiveness or inclusivity of on-farm demonstrations. In particular, until the FarmDemo on-farm demonstration design guide was introduced, there were no established guidelines for organising demonstration events. Good practice, essentially tacit knowledge, was learned through experience. Both AgriDemo-F2F and PLAID sought to address the issue of good practice from different, but complimentary perspectives. AgriDemo-F2F focused on the mechanisms of peer-to-peer learning (i.e. how learning occurs). PLAID focused on access to demonstration (i.e. how to ensure the inclusivity of demonstration), developing guidelines for ‘virtual demonstration’ through video production. The NEFERTITI project has operationalised the lessons learned through AgriDemo-F2F and PLAID to develop 10 new demonstration networks. The integration of the three projects into FarmDemo has yielded a rich body of data addressing the structural and procedural aspects of on-farm demonstration.

To introduce the special issue, we offer some background insights into the conceptual positioning of on-farm demonstration within broader literatures on AKIS and learning processes. We conceptualise on-farm demonstration based on the literature enriched with results presented in this special issue of FarmDemo papers. Utilising these results, we highlight the role of governance and stakeholder collaboration in underpinning effective programmes of demonstration, as well as the operational practicalities of

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**Figure 1.** Conceptual framework of on farm demonstration developed through the FarmDemo collaboration.
implementing effective demonstration events. In particular, we emphasise the importance of proactive planning and evaluation to address inclusivity, experiential learning, and pathways to impact, as well as building inter-organisational collaboration. This is visualised in Figure 1.

2. Conceptualising on-farm demonstration

2.1. Enabling Peer-to-peer learning

It is well established in the academic literature that ‘other farmers’ are farmers’ most frequently reported source of information (Garforth et al. 2003, 324). Farmers learn directly from other farmers in multiple ways: through conversations, and also through visual observation of farming practices. ‘Roadside farming’ – the practice of scrutinising the fields and practices of other farmers to assess their skills and management abilities (Burton 2004; Strand, Arnould, and Press 2014) – enables tacit knowledge to be displayed and communicated non-verbally. In organising on-farm demonstrations, AKIS actors (including farmers) seek to actively mobilise this culture of ‘roadside farming’, by inviting farmers directly onto farms: structuring encounters between farmers where both tacit and codified (scientific) knowledge can be exchanged. The particular strength of demonstration activity is that it enables experiential learning and direct communication between peers. Central in the conceptualisation of demonstration is thus unravelling which forms of learning this peer-to-peer approach can enable.

Burton’s (2020) paper resulting from the PLAID project, a prequel to the special issue, demonstrates both the history and challenges of actively seeking to enable farmers to learn from scientific experts and from other farmers, revealing problems with design which are still relevant today. Burton’s paper traced on-farm demonstration to the eighteenth century, when it was developed by agricultural societies. On-farm demonstration was popularised in the nineteenth century with the advent of ‘model’ or ‘pattern’ farms developed by wealthy landowners, researcher institutions or agricultural societies. However, these interventions had a limited impact on ‘ordinary’ farmers, if the innovations on display were not practically feasible for those farmers to undertake, which often was the case. The popularity of model farms fell by the end of the nineteenth century, but demonstration on more ‘ordinary’ farms was revitalised in the twentieth century, a precursor to on-farm demonstration as it is understood today. Burton’s paper demonstrated that issues associated with effective demonstration are long-standing. Gentlemen farmers of the nineteenth century did not mix socially with common farmers and were, therefore, viewed with suspicion, and in any case were largely unaware of practicalities at local levels. Trust in the motives of these elite farmers (e.g. particularly following land consolidation and clearances) was also a limiting factor. The contemporary emphasis on peer-to-peer learning, held on commercial farms and led by commercial farmers, addresses many of these issues, but there is still much to be learned.

2.2. Experiential learning

In this section we describe the learning concepts utilised by the FarmDemo projects and analyses. There are numerous ways of defining different ‘types’ of knowledge and
learning. First, drawing on a distinction initially made by Polanyi (1958), we distinguish tacit (implicit) and codified (explicit, often scientific) knowledge. Farmers gain tacit knowledge largely experientially: ‘know how’ which is acquired through practice and experience. Tacit knowledge is not necessarily related to cognitive learning (Curry and Kirwan 2014). Farmers make numerous assessments and performances – ranging from identifying sick livestock to creating evenly ploughed fields – without necessarily being able to explain how they do so. In contrast, ‘scientific knowledge’ – typically developed in laboratories and tested in field trials – is ‘codified’: it can be explicitly reported and documented (e.g. through scientific reports) (EU SCAR 2012). This codified knowledge is more frequently mobilised by agricultural advisors, researchers and other academically trained participants in AKIS. However, there is considerable overlap, as farmers typically have a degree of formal academic training in addition to their experiential knowledge, and many AKIS participants have tacit knowledge, gained through lived experience of farming (e.g. being raised on a farm, or farming part-time, while they work as advisors, input suppliers or researchers).

The tacit knowledge held by farmers is often intrinsically linked to their geographical location (Sutherland et al. 2017). Tovey (2008) thus distinguished between local knowledge – which is situated in space – and tacit knowledge – which is grounded in experience. Demonstrations, therefore, offer an important opportunity for new knowledge to be analysed where it is used – that is, in a farm context. The impact of the demonstration activity also reflects its perceived viability, which is best demonstrated on a successful commercial farm. Farmers can readily identify the ‘good farmers’ that they would emulate (Burton et al. 2021). Unfortunately, the desire to be seen as a ‘good farmer’ also leads to unwillingness to share mistakes; competitiveness can also limit willingness to provide access to accurate financial accounting of commercial achievements. However, the same desire to be seen as a good farmer provides a strong motivation for farmers to engage with demonstration farms, to enable them to keep updated with new technologies and processes that can assist them in their farming practices. These ‘good farmers’ may be difficult for outsiders to identify, but they are crucial for influencing change.

The primary purposes of on-farm demonstration are to communicate explicit knowledge, and to make tacit knowledge more explicit. Nonaka and Toyama (2003) identified a four-step process for making tacit knowledge explicit: socialisation, externalisation, combination and internalisation. These steps build upon each other. ‘Socialisation’ is the facilitated experience of hands-on learning: the learner is intentionally exposed to an environment that induces personal experiences. When tacit knowledge is articulated (e.g. as concepts or principles), it becomes explicit – a step called ‘externalisation’. ‘Combination’ activities mingle this knowledge with that of other people, systemising and integrating it. Then, when the new knowledge is practically applied in a new situation – such as to the learning farmer’s farm – it becomes internalised, embodied in farming practices (Nonaka and Toyama 2003, 5). These stages can be clearly seen at demonstration events: farmers attending the event are typically given the opportunity for ‘hands-on’ learning, socialising them directly with the innovation in an applied setting. Explanations of the innovation externalise the knowledge, making it more explicit; discussion with experts and other demonstration participants enable it to be combined with other knowledge. If a farmer decides to implement the innovation, the final step – internalisation – occurs after the farmer returns to their farm and employs the innovation.
In addition, recent literature has advocated for learning and innovation processes to better include reflection on material elements and their visual, auditory, tactile and olfactory experiences (Berthet, Hickey, and Klerkx 2018; Darnhofer 2020). The ‘more-than-human’ and ‘more-than-representational’ turns across the social sciences have challenged the human-centric and cognition-focused emphasis of recent research. This creates opportunities to further explicit what ‘hands on’ learning can entail during on-farm demonstrations. Cooreman et al. (2020), using video-data from the Agri-demo-F2F project, made an initial attempt to go beyond studying interactions between people by also articulating influences of the environmental surroundings an on-farm demonstration can offer. They introduced the concept of tactile space in research on on-farm demonstrations. Tactile space involves interconnections among people (i.e. social embeddedness), and physical negotiations with environmental surroundings (i.e., physical embodiedness). This implies that individuals can see, taste, touch, smell and hear for themselves the phenomena around which knowledge claims and constructs are made (Carolan 2008). Debating sensory experiences (for example, verbally evaluating hands-on examination of the soil, and also deliberately using verbal references to surroundings as starting points for a dialogue) during formal moments, could create an even stronger learning and tactile space by inviting participants to engage in the dialogue and provoking questions (Cooreman et al. 2020).

2.3. Transformative learning

The potential for internalisation depends on the degree to which attendees actively process the knowledge and opportunities available at the demonstration. Social psychological theorists argue that there are two primary pathways to influencing behaviour change. These approaches are termed ‘dual process models’ (Crano and Prislin 2006). ‘Peripheral route processing’ involves limited active reflection; influence relies heavily on the characteristics of the informer or teacher. Farmers engaged in peripheral route processing are likely to make incremental changes, resulting from the advice of credible well-known speakers or trusted advisors. ‘Central route processing’ requires more active reflection, and typically leads to more substantive, durable changes. The latter can be linked to a potential for transformative learning (see Mezirow and Taylor 2009). Frames of reference are transformed through critical reflection on the assumptions upon which our interpretations, beliefs, and habits of mind or points of view are based. To facilitate transformative learning (which is necessary for more substantive whole farming system changes), educators and thus demonstrators must help learners become aware and critical of their own and others’ assumptions. Learners need practice recognising frames of reference and using their creativity to redefine problems from a different perspective.

Both peripheral and central route processing can yield on-farm change. Sutherland et al. (2012) drew on these dual process models in their Triggering Change Model of farmer decision-making. Based on empirical evidence from the UK, they demonstrated that most farmers operate in a steady trajectory of path dependence, owing to the substantive fixed investment – economic, social and cultural – in the status quo. Farmers in this stage are likely to under take peripheral route processing in response to demonstration events, making minor changes in response to the activities of peers or experts.
Major changes to farming operations primarily occur in response to major trigger events, such as integrating a successor into the business, financial duress or a disease outbreak. These trigger events lead to a period of active information seeking, after which, if the innovation appears promising, it is likely to be taken up (at least on a trial basis). The importance of the Triggering Change Model for on-farm demonstration is that if the demonstration activity promotes major changes, farmers who are dealing with major issues are more likely to take up the innovation.

2.4. Network learning

Farmers use a variety of sources during their decision-making processes, and attend demonstration activities for other reasons other than learning about innovations (see also PRO AKIS FP7 - Creaney, McKee, and Prager 2015). Demonstration events are good opportunities for social interaction and establishing new commercial relationships with others who undertake related activities. This ‘network learning’ creates and strengthens bonds of mutual obligation (social capital) and is thus an important benefit of agricultural industry events. Although building social capital is an important entrepreneurship skill, the value of social capital is difficult to measure (Sutherland and Burton 2011). Within the FarmPath FP7 project, Sutherland et al. (2015) found that farm-level innovations were indeed more likely to occur when different subsectors and groups of actors connected, and that the likelihood of coordinated actions increased with prolonged interaction between actors. The EU’s strategy to stimulate European Innovation Partnerships similarly aims to increase innovation and entrepreneurship through facilitating group collaboration. The impact of a demonstration event is, therefore, not limited to the immediate up-take of a particular innovation, and also has the potential support longer term innovation and entrepreneurship.

In the following sections, we offer an overview of the key lessons learned presented in FarmDemo papers in this special issue, utilising these to highlight the diversity of practices, critical issues and options for future research into on-farm demonstration.

3. Diversity of on-farm demonstration

The FarmDemo projects collected data on over 1500 demonstration farms across Europe, demonstrating a wide variety of on-farm demonstrations approaches, which reflect historical and contemporary practices and policy supports for on-farm demonstration in member states. The privatisation of state-funded agricultural advisory services across Europe in recent decades, in combination with the growing demands on farmers to produce food, fibre, energy, rural economic growth and ecosystem services in multiple forms, has led to an increasingly diverse array of demonstration activities and actors who commission and carry them out.

As such, there are many different types of demo events, but they all have in common two pathways of knowledge exchange: farmer-to-farmer and innovation actor-to-farmer. These exchanges can have multiple forms, for example dissemination of knowledge, provision of advice and solutions, co-design of tools and conduction of research. This shows that demo events can be composed of multiple activities depending on their objectives. Within the NEFERTITI project, demonstrations are catalogued along two primary scales:
the number of participants and the degree of peer-to-peer learning. For example, events could aim to maximise the exchanges between farmers (i.e. a high level of peer-to-peer learning) typically organised through small discussion groups or workshops; alternatively, the events could aim to maximise information and innovation (through interactions with innovation actors) more commonly organised through big fairs and open days with machinery demonstrations. However, many different events fall in on the continuum between those axes.

3.1. Enabling level: role of organisations, AKIS and regional context

Demonstrations take place within an increasing complex and diverse arena of new policy and commercial imperatives, volatile costs and markets, changing farm structure, technological innovations and ICT advancements, and fragmented AKIS. In addition, they are situated within, and are not independent of, a wider advisory landscape and AKIS in which innovation is the result of a process of networking and interactive learning among a heterogeneous set of actors, including farmers, input suppliers, processors, traders, researchers, extensionists, government officials, and civil society organisations (EU 2012; Hall et al. 2006). As a result, demonstrations are funded, initiated, coordinated and delivered by multiple actors and arrangements (programmes, networks, etc.) that are active at different spatial and temporal scales, and aim to achieve a range of objectives. These new demands and contexts call for a renewed understanding of role and position of farm demonstrations in the advisory landscape.

The first two papers in this special issue consider these enabling conditions. As Sutherland et al. (2021) demonstrate from their analysis of the joint inventory of on-farm demonstrations collected by the projects, the number of demonstration events available to farmers reflects broader funding patterns for agricultural advisory services across Europe. On-farm demonstrations are more common in Northern Europe, where funding for advisory services and farming organisations is strongest. There are comparatively few on-farm demonstrations in southern Europe, particularly Mediterranean regions, where state funding for advisory services is low or non-existent. Where they exist, demonstrations are instead provided by research institutes and farmers themselves. In Eastern Europe, where on-farm demonstrations are a relatively new innovation, frequency of on-farm demonstration again reflects state funding, with particularly well-developed programmes in Poland, where there is a highly centralised state-funded advisory service.

Ingram et al. (2021) delve into the role of on-farm demonstrations in these broader agricultural knowledge and innovation systems (AKIS), focusing particularly on agricultural advisory services. Ingram et al.’s qualitative analysis of 35 case studies supports the findings of the inventory analysis, illustrating how the different funding structures play out in the organisation of on-farm demonstrations. They found that Europe’s Farm Advisory System regulation is a key mechanism for enabling provision of advice. In broad terms, countries with well-funded agricultural advisory services – either publicly or through other mechanisms such as farming organisations (i.e. Northern Europe) – had more integrated and extensive programmes of on-farm demonstration. Demonstration was embedded within formalised structures. Organisers were able to tap into
expertise from a range of AKIS actors, and build on on-going relationships with farmers, researchers, and advisors, to plan and carry out demonstrations, and integrate them within on-going farmer learning programmes. Ingram et al. found that organisation of on-farm demonstrations can serve as an opportunity for greater integration of the AKIS, through collaborative working. However, this reliance on state funding did lead to some restrictions in topic and host selection for demonstration events. In contrast, more pluralistic AKIS were characterised by more flexible approaches to on-farm demonstration, responding more easily to emergent needs, but were fragmented. The need to secure funding from various sources led to a reliance on sponsorship from commercial partners, short-term contracts or farmers themselves to cover costs. All of these sources influenced topic selection, and increased transaction costs between organising entities. Ingram et al.’s analysis suggests that while many organisations adapt to the absence of public funding, they could benefit from support targeted towards systems for enabling mechanisms for farmer involvement in demonstration programme governance and for planning and delivering coherent learning for farmers with an integrated approach supported by mentors and advisers in the longer term.

Sutherland et al. (2021) consider how the organisation of on-farm demonstration by different actors is reflected in the participation at these events. The inclusivity of contemporary agricultural advisory services, in general, has been the subject of considerable recent concern, with attention drawn to the practices and drivers (particularly privatisation) which disadvantage some farming cohorts (e.g. Labarthe and Laurent 2013; Sutherland et al. 2017). The plurality of advisory services described by Ingram et al. also influences the inclusivity of participants. Sutherland et al. found that although on-farm demonstrations across Europe were reaching younger farmers than the European norm (i.e. farmers between the ages of 25 and 55), there were reasons for concern about gendered patterns of participation. On-farm demonstrations in eastern Europe, where there are higher percentages of female-led farms, were likely to include higher percentages of women amongst demonstration providers. In northern and southern Europe, where female-led farms tend to be less common, so was female attendance at events. While this could be expected given the demographic structure of the agricultural sector in these countries, Sutherland et al. found evidence that the gendered pattern of participation is reinforced by the advisory services and farming organisations when they organise on-farm demonstrations. In broad terms, advisory and extension services reported male attendance of least 75%. Supply chain companies similarly reported high percentages of male attendance, suggesting an additional weakness of relying on their support for demonstration organisation. In contrast, NGOs, charities, research organisations and farmers themselves when they organised demonstrations, reported more equal gender balance. In addition, on-farm demonstrations appear to be more common in profitable farming areas, where AKIS actors have co-located; although it is understandable that organisations would find it most cost effective to offer demonstrations ‘in their backyard’, this practice favours profitable farmers. Sutherland et al. argue that there is a role for publicly funded advisors to actively seek to counter sectoral inequalities through their planning processes for on-farm demonstration. It is to these planning processes that we turn next.
3.2. Operational level: from key success factors to demonstration 2.0

The second set of papers focus on the practical issues or ‘success factors’ associated with organising effective on-farm demonstrations. Adamsone-Fiskovisa et al. (2021b) and Alexopoulos et al. (2021) both contend that the very first steps of planning an on-farm demonstration are of critical importance. On-farm demonstrations are widely regarded as beneficial approaches, but there was a surprising lack of active identification of the purpose and specific goals for the demonstrations planned. Organisers tended to focus on practical planning for the event itself. Without clear articulation of purpose, subsequent decisions about the problem being addressed, choice of location, demonstrators, target participants and ways to reach them with advertising, as well as the means for conveying the demonstration message, become inconsistent. Success factors are thus interlinked; although organisation of a demonstration does not need to start with an objective – it may start from a problem statement, or the interests of personnel – a clear purpose is a fundamental success factor for achieving the desired outcome.

Alexopoulos et al. and Andamone-Fiskovisa et al. point out that topic selection is a particular important but often contentious issue. Funders tend to encourage particular topics, whereas farmers as demonstration participants responded better to topics which addressed their immediate problems and needs. Effectively identifying these needs was particularly challenging for organisations within strongly pluralist AKIS; although farmers can identify general needs, specifically developing this into an operational agenda for on-farm demonstration activities requires a well-mediated process between farmers and organisers (Ingram et al. 2021), if farmers themselves are not leading the event. Ingram et al. pointed to the time required to successfully negotiate topics and messaging between the multiple organisers of on-farm demonstrations, and to come to a position between funder objectives and farmer needs and interests.

Choice of location is also important; farmers expressed a clear preference for demonstrations on commercial farms (Marchand et al. 2021). This is more conducive to peer-to-peer learning, where farmers can physically see their peer’s activities. Choice of location also influences the facilities available (e.g. discussion spaces, seating, toilets, audio visual support), which also influences the effectiveness of the event. However, locating demonstrations on-farms can also add considerable levels of effort for the farmers involved. Adamsone-Fiskovisa and Grivins (forthcoming), in a paper from PLAID published outside of this special issue, point out how agricultural trials organised on commercial farms can require considerable effort from farmers to maintain, but may offer few benefits, particularly if the trial ‘fails’ and the demonstration is held elsewhere. Field conditions may also not yield publishable academic findings, which is problematic for engaging scientists. Ensuring there is time to manage expectations of the various interests of participants, organisers and experts in on-farm demonstration activities is very important.

Marchand et al. (2021) focus specifically on the structure of the demonstration event itself. As a learning activity, demonstrations need to include a variety of learning activities, particularly opportunities for hands-on interaction with the innovation. Activities also need to address a range of learning styles, and require considerable skill to facilitate. Adamsone-Fiskovisa et al. (2021a) found that high-quality facilitation and recognition of the learning styles of participants, along with very practical considerations for smooth
operation of the event, are often overlooked in planning. Group dynamics have a potential impact: in particular, the level of group connectedness and group composition of the event are crucial (Marchand et al. 2021). Opportunities to interact with other participants are important (i.e. a mix between expert and peer interaction). Smaller groups are often more effective, but the authors agree that there is no ‘one-size fits all’ approach to organising a successful event. Alexopoulos et al. (2021) found that a good event design led to positive experience of the event regardless of the AKIS in which the demonstration was organised; that is, even in locations where advisory services were fragmented, demonstration participants had positive learning experiences. Marchand et al. (2021) found that the most important structural characteristics, which add to the effectiveness of a demo event, are the structure of the day, the suitability of the host farm, a trustworthy demonstrator, as well as group size.

Cooreman et al. (2021) hone in on the particular issue of facilitated exchange. Marchand et al. (2021) describe an effective demonstrator as someone who is recognised by the participants as knowledgeable, honest and dedicated; demonstrators also need to have strong facilitation skills, a contention supported by Adamsone et al. (2021a). Facilitated dialogue is a guided knowledge exchange during which different attending participants can share their views and opinions (Cooreman et al. 2021). This approach was surprisingly uncommon amongst the cases studied. Although the cases studied aimed to support peer learning, many demonstrations continued to follow a more traditional linear approach where social interaction was often limited to one-way direction from the demonstrator to the participants (for example, when oral presentations are given) or a two-way social interaction between the demonstrator and the participants (e.g. when a question and answer session is included). Cooreman et al. (2021) argue that an approach that stimulates peer learning needs to go a step further and attempt multiple directions of social interaction between the demonstrator and the participants, and within the group of participants. Marchand et al. (2021) found that if the three basic needs – autonomy, relatedness and competence – are fulfilled by the demonstration event, participants will be more likely to actively join discussions and start an internalisation process of externally regulated behaviours (Ryan and Deci 2000), meaning that they value the practices and might change their behaviour to align with these practices.

The degree of social interaction between the demonstrator and participants and the active engagement required by the farmers is thus crucial. This is a key intervention point and should become the new understanding of what a peer learning demonstration event entails, which we can term as demonstration 2.0. In her PhD dissertation based on Agridemo-F2F data, Cooreman (2021) goes a step further and develops this contention this through the concept of ‘embedded on farm demonstration’ (EOFDs), defined as authentic learning spaces where farmers and other stakeholders can explore and discuss agricultural practices together in a socially and physically embedded manner. The word ‘authentic’ stresses the specific feature of being in a relatable ‘on-farm’ setting. This definition also steers away from transfer-of-knowledge implicated word choices such as ‘providing’ or unintentionally implying that farmers are not experts by listing them as two different types of actors. Furthermore, it highlights the process that knowledge can be mediated through lived experiences in a sensory-rich embodied manner in the environment offered by an on-farm demonstration (physically
embedded), and through social interactions with different stakeholders (socially embedded) (Cooreman 2021).

### 3.3. Outcomes and output

The goal of on-farm demonstration is to increase the innovativeness and sustainability of the agricultural sector. However, the specific outcomes of individual demonstration activities are difficult to measure owing to the bedding of demonstration activities within larger learning programmes and AKIS activities. In addition, as Alexopoulos et al. (2021) and Cooreman et al. (2021) point out, better understanding of a potential innovation gained through an on-farm demonstration may lead to the recognition that the innovation is not suited to the farmer’s business. Marchand et al. (2021) hypothesise that the creation of farm demos as a motivational space, based on a good facilitation and peer learning activities, might lead to a better learning process and internalisation of practices shown, whether the innovations demonstrated were implemented on participants farms or not. There are also topical issues surrounding impact which obfuscate the quality of the demonstration itself: demonstration events targeted at dealing with urgent industry issues were more popular with farmers and likely to be high impact. Other demonstration participants, who were not dealing with these issues, could attend the same event but engage in peripheral route processing, storing basic information for later consideration. However, if the demonstration promotes relatively minor changes, and involves well-respected ‘experts’, then broad up-take is more likely. As a result, a well-designed demonstration activity may not lead to immediate up-take for the majority of participants, depending on how radical a change is demonstrated and a number of factors which are completely separate from the demonstration. Sectoral factors like the profitability of commodities, and factors internal to the farm such as farm succession, influence the potential up-take of the innovation being demonstrated regardless of the ‘quality’ of the demonstration event.

On-farm demonstrations also have considerable secondary benefits, particularly building social capital and networks between farmers (Adamsone-Fiskovica et al., 2021b; Ingram et al. 2021) as well as collaborations between demonstration organisers (Ingram et al. 2021). The ultimate objective of on-farm demonstrations is to contribute to empowered, knowledgeable and aware farmers, but this is challenging to assess in terms of innovation up-take, or indeed the social capital built. One option is to consider who is likely to benefit from on-farm demonstration. While on-farm demonstrations are arguably reaching those farmers who are best positioned to implement innovations, Sutherland et al. (2021) argue that publicly funded advisory services may be perpetuating patterns of marginalisation for women, older farmers and those located in remote regions. This is a structural issue relating to demonstration promotion, more so than an issue with event design; Alexopoulos et al. (2021) found that once at the event, the learning experience of participants did not reflect differences in age, gender or farming experience.

### 4. Conclusion

Although organising on-farm demonstrations is a common practice for AKIS actors across Europe, to date there has been very little associated academic literature. The
papers in this special issue thus represent an initial step towards describing the learning processes embedded in on-farm demonstration, how these can be improved, and the role of on-farm demonstration within AKIS and the agricultural sector more broadly. As a set, the papers identify a number of issues for further research. In particular, the FarmDemo project jointly produced the first inventory of on-farm demonstration across Europe. In doing so, the challenges of comparison between and within European countries became particularly evident – the highly variable AKIS, in combination with the wide range of topics and approaches to demonstration, made for a large degree of heterogeneity in the dataset. Quantitative analysis is important for assessing the ubiquity of particular phenomena, but is particularly challenging in this context. Analysis of the inventory dataset suggested potential structural inequalities in access to demonstration which may be being perpetuated by publicly funded institutions; these issues require further exploration, particularly the connection between the gender of participants and the characteristics of the organisers. The analysis also revealed the challenges faced in countries where AKIS are highly pluralist and there is limited financial support for advice. Further research is particularly needed into how highly pluralist AKIS can be enabled to develop and embed on-farm demonstration within longer term programmes of learning for farmers, enabling capacity at multiple levels to be built over time. One option is to specifically address these issues within the national CAP Strategic Plans being implemented across the EU, which are specifically tasked with including AKIS supports.

The FarmDemo projects also assessed the practices of on-farm demonstration. The importance of skilled facilitation and attention to enabling different types of learning cannot be stressed enough; experts – particularly scientists and also professional advisors – are not necessarily skilled at facilitating the type of interactive communication which was found to be most effective at demonstration events. Future research could focus on identifying how the presence of different roles (e.g. untrained demonstrator vs. trained demonstrator in fostering different learning processes; participation of advisers, salesmen, researchers, younger vs. older farmers etc.) shape different types of interactions and influence learning about farming systems over the long term. It will also be important to assess how these roles shape demonstration when all participants are not physically present. The movement restrictions resulting from the covid-19 pandemic have demonstrated the opportunity of on-line and ‘virtual’ approaches to knowledge exchange and demonstration. Klerkx (2021) in his recent editorial has emphasised the potential of digital/on-line and hybrid environments, as well as social media, for knowledge exchange and learning. Virtual facilitation requires a high level of skill, and poses new challenges in enabling experiential learning. In addition, while these approaches can reduce some barriers, particularly in relation to gender, they can raise others, further marginalising older farmers and those with limited broadband access or digital skills.

Cooreman (2021) also argues that further research is needed to shape our understanding of on-farm demonstrations as learning spaces incorporating core factors fostering transformative learning (e.g. fostering disorienting dilemma, critical reflection and facilitated dialogue) and to better understand the specific nature of on-farm demonstrations as a tactile space. Engagement with the ‘more-than-representational’ turn more directly could also enable better understanding of how demonstration events
are experienced and integrated into farming businesses. The broader impacts of demonstration also warrant consideration. This refers both to the social capital built between participants and organisers, and impacts outside of the event participants. Ingram et al. (2021) found that very few organisers of demonstrators seek to assess the impacts of demonstration activities on farmers who did not participate in the actual event. Evidence from the FarmDemo projects suggests that on-farm demonstration will continue to be an important tool for agricultural extension; ensuring that these demonstration events are high impact will be an important task of AKIS actors for the years to come.

As a final note, in addition to generating new knowledge about on-farm demonstration across Europe, the FarmDemo projects were themselves a sort of experiment. The FarmDemo projects are an example of new approaches within European Commission funding, where projects are intentionally commissioned in clusters so that they can build on each other. AgriDemo-F2F and PLAID were funded under the same call in 2017 (RUR-11-2016 On-farm demonstrations: deepening farmer-to-farmer learning mechanisms), which specifically called for the creation of a European inventory of on-farm demonstration and evaluation of best practice. The call identified substantial funding for an overlapping project which would start a year later (RUR-12-2017: Networking European farms to boost thematic knowledge exchanges and close the innovation gap – which became NEFERTITI). Based on the iterative method of continual improvement of processes, products or services, the Plan-Do-Check-Act cycle (also known as the Deming wheel), NEFERTITI is implementing and improving on-farm demonstration events. Lessons learned through the Agridemo-F2F and PLAID case study analyses are being employed in NEFERTITI to establish 10 networks of on-farm demonstration across Europe. The process involved substantial transaction costs: three separate grant agreements, harmonisation of three Gantt charts and plans of work, and collaboration across three consortiums (totalling 47 organisations). The results have been very rich, and are on-going, including: a joint inventory of over 1500 demonstration farms across Europe, good practice materials, policy recommendations, a PhD dissertation (Cooreman 2021) and the papers described in this editorial. Outputs of the three projects are available on the FarmDemo website (www.farmdemo.eu), which also offers practical resources to farmers and other demonstration organisers on the training kit page, a searchable inventory of on-farm demonstrations, and an opportunity to join the NEFERTITI FarmDemo networks.

Notes
1. https://i2connect-h2020.eu/
2. https://farmdemo.eu/hub/storage/doc/818_Design_guide_en.pdf
3. The triggering change model is being further developed in the H2020 AgriLink project www.agrilink2020.eu

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**References**

Adamsone-Fiskovica, A., M. Grivins, R. J. F. Burton, B. Elzen, S. Flanigan, R. Frick, and C. Hardy. 2021a. “Disentangling Critical Success Factors and Principles of On-Farm Agricultural Demonstration Events.” *The Journal of Agricultural Education and Extension* 27 (5): 639–656.

Adamsone-Fiskovica, A., and M. Grivins. Forthcoming. “Knowledge Production and Communication in On-Farm Demonstrations: Putting Farmer Participatory Research and Extension into Practice.” *Journal of Agricultural Education and Extension*. https://doi.org/10.1080/1389224X.2021.1953551.

Alexopoulos, Y., E. Pappa, I. Perifanos, F. Marchand, H. Cooreman, L. Debruyne, H. Chiswell, J. Ingram, and A. Koutsouris. 2021. “Unravelling Relevant Factors for Effective on Farm Demonstration: The Crucial Role of Relevance for Participants and Structural Set Up.” *Journal of Agricultural Education and Extension* 27 (5): 657–676.

Berthet, E. T., G. M. Hickey, and L. Klerkx. 2018. “Opening Design and Innovation Processes in Agriculture: Insights from Design and Management Sciences and Future Directions.” *Agricultural Systems* 165: 111–115.

Burton, R. J. F. 2004. “Seeing through the ’Good Farmer’s’ Eyes: Towards Developing an Understanding of the Social Symbolic Value of ’Productivist’ Behaviour.” *Sociologia Ruralis* 44: 195–215.

Burton, R. J. F. 2020. “The Failure of Early Demonstration Agriculture on Nineteenth Century Model/Pattern Farms: Lessons for Contemporary Demonstration.” *The Journal of Agricultural Education and Extension* 26 (2): 223–236.

Burton, R. J. F., J. Forney, P. Stock, and L.-A. Sutherland. 2021. The “Good Farmer”: *Culture and Identity in Food and Agriculture*. London: Earthscan from Routledge.

Carolan, M. S. 2008. “More-than-Representational Knowledge/s of the Countryside: How We Think as Bodies.” *Sociologia Ruralis* 48: 408–422.

Chambers, R., A. Pacey, and L. A. Thrupp, eds. 1989. *Farmers First. Farmer Innovation and Agricultural Research*. London: Intermediate Technology Publications Ltd.
Cooreman, H. 2021. Enhancing Peer Learning for Sustainable Agriculture. On-farm Demonstrations as Spaces for Embedded, Embodied and Transformative Learning. https://lirias.kuleuven.be/retrieve/612607SDCooreman_PhD_metkaft.pdf [Available for KU Leuven users].

Cooreman, H., L. Debruyne, F. Marchand, and J. Vandenabeele. 2021. “Power to the Facilitated Agricultural Dialogue: An Analysis of OFDs as Transformative Learning Spaces.” Journal of Agricultural Education and Extension 27 (5): 699–719.

Cooreman, H., J. Vandenabeele, L. Debruyne, and F. Marchand. 2020. “The Use of Video to Evaluate On-farm Demonstrations as a Tactile Space for Learning.” Sustainability 12 (11): 4342.

Crano, W., and R. Prislin. 2006. “Attitudes and Persuasion.” Annual Review of Psychology 57: 345–374.

Creaney, R., A. McKee, and K. Prager. 2015. “Designing, Implementing and Maintaining (Rural) Innovation Networks to Enhance Farmers’ Ability to Innovate in Cooperation with Other Rural Actors.” Monitor Farms in Scotland, UK. Report for PRO AKIS. February 2015. Online resource: www.proakis.eu/publicationsandevents/pubs.

Curry, N., and J. Kirwan. 2014. “The Role of Tacit Knowledge in Developing Networks for Sustainable Agriculture.” Sociologia Ruralis 54: 341–361.

DAES (Department of Agricultural Extension Services). 2015. Lead Farmers Approach Guidelines. Malawi: Ministry of Agriculture, Irrigation and Water Development – DAES.

Darnhofer, I. 2020. “Farming from a Process-Relational Perspective: Making Openings for Change Visible.” Sociologia Ruralis 60: 505–528.

Deci, E. L., and R. M. Ryan. 2000. “The ‘What’ and ‘Why’ of Goal Pursuits: Human Needs and the Self-Determination of Behavior.” Psychological Inquiry 11: 227–268.

Dockès, A.-C., T. Tisenkopfs, and B. Bock. 2011. “Agricultural Knowledge and Innovation Systems in Transition - A Reflection Paper.” In Agricultural Knowledge and Innovation Systems in Transition - A Reflection Paper, 23–46. Brussels: Standing Committee on Agricultural Research (SCAR) Collaborative Working Group AKIS.

European Commission. 2014. “Measure Fiche Knowledge Transfer and Information Actions.” https://www.pndr.ro/leader-2014-2020/fise-template-specifique-propuse-de-ce-utilizate-ca-model-orientativ-elaborare-masuri-sdl/item/download/129_28e7433c3113dba433c92ccff83eae11.html.

European Commission. 2019. “Farm Advisory System.” https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/income-support/cross-compliance/fas_en.

EU SCAR. 2012. Agricultural Knowledge and Innovation Systems in Transition – A Reflection Paper. Brussels.

FAO. 2019. “Farmers Taking the Lead – Thirty years of Farmer Field Schools.” Rome Licence: CC BY-NC-SA 3.0 IGO.

Freire, P. 1968. The Pedagogy of the Oppressed. New York: Seabury Press.

Garforth, C., B. Angell, J. Archer, and K. Green. 2003. “Fragmentation or Creative Diversity? Options in the Provision of Land Management Advisory Services.” Land Use Policy 20 (4): 323–333.

Habermas, J. 1971. Knowledge and Human Interests. Boston: Beacon Press.

Hall, A., W. Janssen, E. Pehu, and R. Rajalahti. 2006. Enhancing Agricultural Innovation: How to go beyond the Strengthening of Research Systems. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/7184.

Ingram, J., H. Chiswell, J. Mills, L. Debruyne, H. Cooreman, A. Koutsouris, Y. Alexopoulos, E. Pappa, and F. Marchand. 2021. Situating Demonstrations within Contemporary Agricultural Advisory Contexts: Analysis of Demonstration Programmes in Europe.” Journal of Agricultural Education and Extension 27 (5): 615–638.

Klerkx, L. 2021. “Digital and Virtual Spaces as Sites of Extension and Advisory Services Research: Social Media, Gaming, and Digitally Integrated and Augmented Advice.” Journal of Agricultural Education and Extension 27: 277–286. https://www.tandfonline.com/doi/full/10.1080/1389224X.2021.1934998.

Klerkx, L., B. Van Mierlo, and C. Leeuwis. 2012. “Evolution of Systems Approaches to Agricultural Innovation: Concepts, Analysis and Interventions.” In Farming Systems Research into the 21st Century: The New Dynamic, edited by I. Darnhofer, D. Gibbon, and B. Dedieu, 457–483. Dordrecht: Springer Science + Business Media.
Knierim, A., P. Labarthe, C. Laurent, K. Prager, J. Kania, L. Madureira, and T. H. Ndah. 2017. “Pluralism of Agricultural Advisory Service Providers – Facts and Insights from Europe.” Journal of Rural Studies 55: 45–58.

Kolb, D. A. 1984. Experiential Learning: Experience as the Source of Learning and Development. Englewood Cliffs: Prentice-Hall.

Koutsouris, A., and Zarokosta E. 2020. “Supporting bottom-up innovative initiatives throughout the spiral of innovations: Lessons from rural Greece.” Journal of Rural Studies 73: 176–185.

Koutsouris, A., E. Pappa, H. Chiswell, H. Cooreman, L. Debruyne, J. Ingram, and F. Marchand. 2017. “The Analytical Framework: Demonstration Farms as Multi-Purpose Structures Providing Multi-Functional Processes to Enhance Peer-To-Peer Learning in the Context of Innovations for Sustainable Development.” Report for AGRIDEMO-F2F. Online resource: https://agridemo-h2020.eu/docs/Rapport_AGRIDEMO_analytical%20framework.pdf.

Labarthe, P., and C. Laurent. 2013. “Privatization of Agricultural Extension Services in the EU: Towards a Lack of Adequate Knowledge for Small-Scale Farms?” Food Policy 38: 240–252.

Labarthe, P., L.-A. Sutherland, B. Elzen, and A. Adamsone-Fiskovica. 2018. “Advisory Role in Farmers’ Micro Systems of Agricultural Knowledge and Innovation (microAKIS).” International Farming Systems Conference Proceedings, Chania, Crete.

Marchand, F., H. Cooreman, E. Pappa, I. Perifanos, Y. Alexopoulos, L. Debruyne, H. Chiswell, J. Ingram, and A. Koutsouris. 2021. “Effectiveness of On-farm Demonstration Events in the EU: Role of Structural Characteristics.” Journal of Agricultural Education and Extension 27 (5): 677–698.

Mezirow, J., and E. W. Taylor, eds. 2009. Transformative Learning in Practice: Insights from Community, Workplace, and Higher Education. San Francisco: Wiley.

Moschitz, H., D. Roep, G. Brunori, and T. Tisenkopfs. 2015. “Learning and Innovation Networks for Sustainable Agriculture: Processes of Co-evolution, Joint Reflection and Facilitation.” The Journal of Agricultural Education and Extension 21: 1–11.

Nonaka, I., and H. Toyama. 2003. “The Knowledge-Creating Theory Revisited: Knowledge Creation as a Synthesizing Process.” Knowledge Management Research & Practice 1: 2–10.

Prager, Katrin, and R. Creaney. 2017. “Achieving On-farm Practice Change through Facilitated Group Learning: Evaluating the Effectiveness of Monitor Farms and Discussion Groups.” Journal of Rural Studies 56: 1–11.

Röling, N. 2002. “Issues and Challenges for FFS: An Introductory Overview.” Paper presented at the international learning workshop on FFS: Emerging issues and challenges, Yogyakarta, October 21–25.

Röling, N. G., and M. A. E. Wagemakers, eds. 1998. Facilitating Sustainable Agriculture: Participatory Learning and Adaptive Management in Times of Environmental Uncertainty. Cambridge: Cambridge University Press.

Strand, K., E. Arnould, and M. Press. 2014. “Tillage Practices and Identity Formation in High Plains Farming.” Journal of Material Culture 19: 355–373.

Sutherland, L.-A., and R. J. F. Burton. 2011. “Good Farmers, Good Neighbours? The Role of Cultural Capital in Social Capital Development in a Scottish Farming Community.” Sociologia Ruralis 51: 238–255.

Sutherland, L.-A., R. J. F. Burton, A. Adamson-Fiskovica, C. Hardy, and B. Elzen. 2021. “Enabling Access to On-farm Demonstration: Gender, Age and Geographical Factors.” Journal of Agricultural Education and Extension 27 (5): 142–151. doi:10.1080/1389224X.2020.1828115.

Sutherland, L.-A., R. J. F. Burton, J. Ingram, K. Blackstock, B. Slee, and N. Gott. 2012. “Triggering Change: Towards a Conceptualisation of Major Change Processes in Farm Decision-Making.” Journal of Environmental Management 104: 142–151.

Sutherland, L.-A., I. Darnhofer, L. Zagata, and G. A. Wilson, eds. 2015. Transition Pathways Towards Sustainability in Agriculture: Case studies from Europe. Wallingford: CABI.

Sutherland, L.-A., L. Madureira, V. Dirimanova, M. Bogusz, J. Kania, K. Vinohradnik, R. Creaney, D. Duckett, T. Koehnen, and A. Knierim. 2017. “New Knowledge Networks of Small-Scale Farmers in Europe’s Periphery.” Land Use Policy 63: 428–439.
Tovey, H. 2008. “Introduction: Rural Sustainable Development in the Knowledge Society Era.” *Sociologia Ruralis* 48: 185–199.

van Crowder, L., and J. Anderson. 1997. “Linking Research, Extension and Education: Why is the Problem so Persistent and Pervasive?” *European Journal of Agricultural Education and Extension* 3: 241–249.

van den Berg, H., S. Phillips, A. Poisot, M. Dicke, and M. Fredrix. 2021. “Leading Issues in Implementation of Farmer Field Schools: A Global Survey.” *The Journal of Agricultural Education and Extension* 27 (3): 341–353. doi:10.1080/1389224X.2020.1858891.

WUR. 2021. https://www.wur.nl/en/Research-Results/Chair-groups/Plant-Sciences/Farming-Systems-Ecology-Group/Lighthouse-project.htm.