Enabling Practice-driven Innovation in the Animal Production Sector

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Abstract: Using the laying hen sector as a case study, the EU-H2020-funded Hennovation project has been testing mechanisms to enable practice-driven innovation through the establishment of innovation networks of farmers and within the laying-hen-processing industry that are facilitated to proactively search for, share and use new ideas to improve hen welfare, efficiency and sustainability. Networks are variably supported by scientists, veterinarians, advisors and others. Nineteen multi-actor networks have been mobilised on local and regional levels across the UK, Sweden, Netherlands, Spain and Czech-Republic.

Practice-driven innovation processes were network specific and evolved as the actors within the network came together to share common problems, experiment with possible solutions and learn. Their success was also affected by the institutional context, the structure of the poultry sector, current market forces and wider Agricultural Innovation Systems in each country. This paper explores the circumstances considered necessary by the facilitators to enable practice-driven innovation, providing examples of conditions affecting the innovation process. Further influences included conditions for innovation to happen (e.g. shared opportunity, motivation and knowledge), conditions to work effectively as a network (e.g. trust, collective purpose and contacts) and conditions for successful application in practice (e.g. capacity within the production system and market and legislative ability).

Key words: Practice-driven, Innovation, Multi-actor networks, Conditions, Facilitation.

1. Introduction

1.1 The need for innovation in the animal production sector

Farming nowadays is conducted in an increasingly dynamic and unpredictable setting where legislation, assurance requirements, environmental circumstances and consumer interest in animal welfare and sustainability place ongoing pressure for change in commercial animal husbandry (World Bank, 2006; Hall, 2007). The role of farming in rural areas has changed from being merely productive towards a multifunctional role delivering a range of public goods (Van Huylenbroeck *et al.*, 2007; Van der Ploeg *et al.*, 2000). These public goods address societal demands such as biodiversity, cultural heritage, environmental quality and animal welfare. Farmer innovation - change towards more sustainable production practices on-farm - is an essential response needed by farmers to cope with and adapt to the challenges described above (Hoffmann *et al.*, 2007). Encouraging farmers to innovate and adopt more welfare-friendly husbandry practices remains a critical challenge for animal welfare improvement. A variety of mechanisms currently exist to make farmers comply with societal demands, including conventional compulsory regulatory rules and standards, market driven compliance to retailer standards for meat and animal products, and voluntary standards

through farm assurance schemes (Brunori *et al.*, 2008; Main *et al.*, 2003). It is increasingly recognized that in addition to compliance mechanisms more participatory approaches focusing on knowledge generation and collective learning may also be necessary to achieve sustainable farm practice change (Darnhofer *et al.*, 2010; Lankester, 2013; Wals and Corcoran, 2012; Reed, 2008). These approaches shift the view of farmers as adopters to being active partners in a collaborative learning process with other stakeholders together identifying and developing solutions (Schut *et al.*, 2014). There is a growing policy interest in agricultural innovation generated through these collaborative knowledge creation processes involving both farmers and scientists; also referred to as co-innovation. The EU H2020 research strategy, for example, is currently promoting a multi-actor and interactive approach to innovation that includes a high level of farmer engagement (SCAR, 2013).

1.2 Fostering local innovation

Stringer and Reed (2007) argue that innovation requires the combination of different types of knowledge, creating a diversity of knowledge where farmers and researchers are partners in a process of learning and co-generation of new knowledge with emphasis less on the individual farmers and more on innovation as a collective process. Approaches for fostering innovation revolve around both creating space for learning and knowledge sharing and enabling conditions for innovation, e.g. bringing together a variety of actors with different knowledge and experience and the ability to work together effectively, combined with the resources to do this (Spielman and Birner, 2008). Examples of these approaches in practice include the forming of innovation networks (Klerkx *et al.*, 2010; Moschitz *et al.*, 2015), Innovation Platforms (Homann-Kee Tui *et al.*, 2013; Kilelu *et al.*, 2013; Nederlof *et al.*, 2011) and Farmer Field Labs (MacMillan and Benton, 2013). The innovative practices generated through these approaches are context specific, participatory, and adaptive, hence uncertain in process and end-result (Coutts *et al.*, 2016; Klerkx *et al.*, 2012). This raises particular challenges in operationalizing innovation, especially in contexts where innovation is still interpreted as essentially 'top-down' and linear (Klerkx *et al.*, 2017).

Reviewing the literature on implementation of these approaches (Hermans *et al.*, 2015; Wettasinha *et al.*, 2016; Nederlof *et al.*, 2011; Klerkx and Jansen, 2010; Turner *et al.*, 2016; Coutts *et al.*, 2016; Moschitz *et al.*, 2015) key areas enabling or hindering innovation emerged:

- the capacity of the actors involved in the process,
- the environment in which they operate e.g. the institutional context, legislative and regulatory environment, market forces and wider Agricultural Innovation Systems in a specific country,
- the availability of an innovation intermediary, broker or facilitator.

The role of farmers as partners in these approaches requires a certain capacity to participate defined by Klerkx *et al.* (2010 p391) as innovation agency: '*the ability to take action and make a difference over the course of an event*' and this ability is '*determined by resources and competencies that an actor has at its disposal for innovation, knowledge, skills, materials and financial resources*'. Farmers are not a homogeneous group and their agency, interest (motivation) and time to participate varies widely (Probst *et al.*, 2003); Wettasinha *et al.* (2016) identified several core capacities required by farmers to innovate: the ability to identify and prioritise problems and mobilise resources, plus a willingness to take certain risks and to link with others to share knowledge and collaborate effectively in collective action.

These practices also require other actors involved to adopt novel roles: in particular the role of advisory services changes from transfer of knowledge to that of knowledge broker (brokering of the scientific and practical knowledge that partners bring into the process) and 'manager'

of a dynamic innovation process (Klerkx *et al.*, 2012). This role is different from more traditional advisory services and involves the mobilization of networks, guiding the network through the innovation process and promoting learning and linking with support actors (Klerkx *et al.*, 2012; Röling, 2009). It requires different capacities of the advisory services and different attitudes, knowledge and skills (Roling, 1990). Knickel *et al.* (2009) indicate that in many countries there is insufficient capacity of advisory services to facilitate this innovation process.

1.3 Practice-led innovation in the egg-laying hen sector

Using the egg-laying hen sector as a case study, the EU-funded 'Hennovation' project has been testing mechanisms to enable innovation through the establishment of innovation networks of farmers and the laying hen processing industry, supported by existing science and market-driven actors. These networks were facilitated to proactively search for, share and use new ideas to improve hen welfare, efficiency and sustainability. In total, 19 multi-actor networks were mobilised on local and regional levels across the Czech Republic, The Netherlands, Spain, Sweden, and the United Kingdom. The networks worked specifically on two areas of concern: feather (or injurious) pecking on-farm and the transport and use of end-of-lay hens. Farmer-led networks focussing on injurious pecking were formed from larger pre-existing farmer groups connected to a specific egg-packing company, farm assurance schemes or veterinary practice, or simply through friendship; others were generated from farmer interest and were brought together by the project. The network size of the on-farm networks varied from three to 25 members and were variably supported by scientists, veterinarians, advisors, feed companies and so on, according to the specific topic addressed by the network. Network meetings were almost always face to face, though some used telephone meetings to overcome the organisational issues that arose with a geographically dispersed network. Industry-led networks focussing on end-of-lay were brought together by the project and included a variety of actors such as the major laying-hen processors in a country, poultry handling equipment manufacturers, large egg producers and egg processors, managers of catching teams, feed company representatives, farmers' organisations representatives, advisors and veterinarians.

Over a period of 12 to 18 months the network actors were facilitated through an iterative process of assessing and 'testing' the technical and economic viability of on-farm and end-of-lay solutions. The process was driven by the innovation needs of the networks and comprised six steps: 1. the identification of the need for innovation (shared problem/opportunity); 2. the generation (and assessment) of innovative ideas which could provide potential solutions; 3. the selection of an innovative idea and planning of action to 'test' the idea, including resources required in terms of time, technical support and money; 4. the practical 'testing' / development of the idea on-farm, during transport or at the slaughter house; 5. the implementation and upscaling of the innovation in practice; and finally 6. the wider dissemination of the innovation amongst the sector. These networks tackled a range of technical challenges including feather loss, red mites and the handling of end-of-lay hens through the development of different types of innovations. Alongside technical or 'hard' innovations (e.g. new type of litter or feed additive), a variety of 'soft' innovations also emerged through these networks: in process (e.g. change in husbandry practices); in marketing (e.g. new way of marketing low valued hen meat); and in organizational structures (e.g. new relationships with different actors).

1.4 Aim of the paper

A wide diversity in the progress and functioning of the innovation networks in the Hennovation project was observed. Some networks were successful in developing their

innovative ideas and some were less successful and faced many challenges on their way. Research was undertaken to explore why this was observed and what factors enabled or hindered innovation to occur. This paper presents the results of part of this inquiry and provides initial insight in the hindering and enabling factors to practice-driven innovation in the particular context of the project.

2. Methodology

This paper is based on the results of a focus group discussion (FGD) with 11 innovation network facilitators involved in the Hennovation project. Examples to illustrate the factors identified during the FGD are drawn from data on network performance collected using a project wiki and data from interviews with the facilitators conducted by social scientists involved in the project. It should be emphasised that this is paper is exploratory, part of a larger research effort to identify mechanisms to enable practice-led innovation.

The FGD was held as part of a reflection workshop organised for the facilitators in November 2016 to share progress and experiences, reflect on the innovation process and its outcomes, and discuss potential challenges. The FGD was facilitated by the facilitators' coordinator who supported the facilitators and acted as 'reflexive monitor', probing the way the facilitators worked and their underlying assumptions through reflection workshops (Van Mierlo *et al.*, 2010; Botha *et al.*, 2014). The facilitators were asked to reflect on their own experience in facilitating the innovation networks and to discuss in smaller groups what they perceived as factors enabling and hindering practice-driven innovation in their network context.

3. Results and discussion

3.1 Overview of the enabling factors identified

Through group discussion, the facilitators listed the factors they perceived as enabling and hindering practice-driven innovation. These were discussed and sorted in plenary and a list of 13 enabling factors was developed (Table 1). The facilitators decided to focus on enabling factors only - as in many cases the hindering factor was the absence of the enabling factor. Further discussion lead to categorization of the factors into three categories: conditions to work effectively as a network, conditions for innovation to happen, and conditions for successful application in practice. It was recognised, that although these categories were helpful in conceptualising the factors, several factors played an enabling role in more than one category and many are inter-related. The enabling factors are listed in Table 1 which uses examples of how these emerged in the process of facilitating practice-driven innovation in the laying-hen sector in the five project countries to further explain each category.

Table 1 Factors enabling practice-driven innovation in the laying hen sector identified by the network facilitators.

Category	Enabling factors
Conditions for networking	Shared common problem (or opportunity) Mutual trust Pre-existing relationships (contacts) Time and resources
Conditions for innovation	Access to different sources of knowledge Collective motivation to change Internal legitimacy (network). Practical engagement (learning by doing) Effective facilitation
Conditions for application	External legitimacy Access to external resources and support Legislative and regulatory support 'Space' for innovation within the system

Conditions to work effectively as a network

The facilitators' discussions revolved around factors enabling farmers, members of the laying-hen processing industry and existing science and market-driven actors to form and effectively function as a network. The discussion focussed specifically on factors supporting network mobilization and formation, on the need for a network to have a *shared common problem (or opportunity)*, *mutual trust*, the importance of having *pre-existing relationships (contacts)* and the *time and resources* to participate in a network.

The facilitators discussed what motivated farmers and members of the laying-hen processing industry to form a network and they listed the importance of network members having a *shared common problem (or opportunity)* within their production systems which fitted their business or personal interests. For the on-farm networks, the Hennovation project addressed a generic challenge: feather (or injurious) pecking driven by the concern of upcoming EU legislation prohibiting beak trimming. Beak trimming is currently one of the most commonly used measures to reduce the impact of feather pecking. For some networks, this policy change was a direct driver or motivation to join the network. For several others, however, the motivation to join a network was market driven (and potentially indirectly influenced by policy). For example, one of the networks in The Netherlands was interested in reducing feather pecking as there was a demand from the German market for eggs from non-beak-trimmed birds; whereas several producers in the UK were interested in forming a network as they were required to reduce feather pecking to remain certified by the farm assurance scheme (and able to supply to a major retailer in the UK). However, some producers did not perceive feather pecking as a major problem and, in some cases, the upcoming policy change was considered too controversial for a topic of mutual interest. In these instances, other problems, often related or potential risk factors for feather pecking, were discussed by the network members, such as, for example, problems with poultry red mites which lead to egg-production losses and increased hen mortality as well as causing itchiness and attracting pecking by conspecifics.

After initial common ground was found, the networks explored and discussed what to focus on in more depth. In several cases, the network members already had a clear idea of what they would like to work on and the project created an opportunity to materialise these ideas. In these cases, the idea was often generated by one or two individuals as part of the network who were enthusiastic about a specific idea. In other networks, ideas were generated through facilitated discussion. Often, when a lot of ideas were generated, the networks needed support in determining what was feasible and practical to take forward. Some of these ideas were generated by network members based on their own knowledge and experience, while others emerged from awareness of scientific research in the field (usually through input from the facilitator or an external actor).

Although several networks had a shared problem in common, the facilitators learned this was not enough to work effectively and they indicated that in some networks a low level of *mutual trust* between the network members limited the sharing of experiences and ideas. The level of trust between network members varied with the extent to which individuals in the network had *pre-existing relationships* of trust with others in the network. The networks were formed in different ways: 13 networks were formed from larger pre-existing producer groups connected to a specific egg-packing company or veterinary practice, two were pre-existing farmer groups and nine were brought together by the project based on members' interest. Hence, especially in newly formed on-farm networks it took time to build trust amongst network members. A significant factor that influenced the levels of trust in the networks was the market context. For example, relationships were shaped by the kind of (egg) production

contract farmers had, and whether these fostered collaboration or competition between farmers.

Trust between the facilitator and network members was also important, especially at an initial stage of network mobilization and formation. Facilitators who were known in the sector and had *pre-existing relationships and contacts* in the sector found it easier to mobilize networks (and support actors). Working with these key contacts (or intermediates) was perceived by the facilitators as pivotal in enabling network formation. Facilitators who did not have these pre-existing relationships with key contacts, and were relatively new to the sector, found network mobilization challenging and particularly time consuming.

Building trust between network members and between the facilitator and the network members took time, more time than most facilitators anticipated. The facilitators discussed how the availability of *time and resources* of individual network members enabled or hindered innovation. The facilitators experienced a large variety between networks in terms of time availability and commitment of network members. Some networks met five to six times over a period of 12 to 18 months, whilst others struggled to meet three times. The facilitators perceived the time and commitment of network members depended on whether members regarded participation in a network as a good use of their time, e.g. whether the discussion in the network was relevant to them and fitted with their business and personal interest, and whether they perceived a benefit from the anticipated outcome of the process. The facilitators also indicated it was important to organise meetings at times of the day or year that were convenient for the network members: several networks met up early in the evening, and where farmers managed multi-enterprise businesses, e.g. in the UK egg producers are often arable farmers and less available while planting and harvesting. For others, the actual geographical distance between members limited their time (and resource e.g. high cost to travel) availability; for example, in a network in Sweden, members lived 400 km apart and communicated mainly through monthly phone meetings.

The issue of risk was also discussed in relation to the ability of an individual to commit time and resources to the network. Most innovative ideas that were discussed and tested lead to incremental rather than radical changes because farmers were constrained by narrow financial margins and could not afford to risk those margins; yet were seeking new ideas to improve profitability. Motivation of farmers to meet in person was tempered by perceived biosecurity risk during avian influenza outbreaks particularly applying to farmers in the Netherlands and the UK. Increased biosecurity measures required free range hens to be kept indoors and many farmers no longer had the time to be engaged in the process and meetings were put on hold. Interestingly, for the network in the UK testing novel litter material, there was an increased interest in their activities as this idea that became more relevant when the hens were required to be kept indoors. Farmers previously not part of the innovation network wanted to join in the innovation process.

3.1 Conditions for innovations to happen

Further discussion in the facilitators' focus groups revolved around how to enable innovation to emerge within established networks. Facilitators listed the following factors: having *access to different sources of knowledge*, having a *collective motivation to change*, *internal legitimacy* (as a network valuing the process and having the confidence of being able to innovate), having the opportunity to *engage in a collective learning process*, and *having effective facilitation support.*

The Hennovation project promoted a practice-driven approach to (co-)innovation whereby the knowledge from experiences of 'doing', the practices of farming and the laying-hen processing industry formed the basis for innovation. Members brought their knowledge to the

network and, with the support of scientific and market-based actors, used this situated knowledge to innovate. The focus group discussion revealed that in many networks *access to different sources of knowledge* enabled the innovation process to progress. As the composition of networks varied, the first step in the innovation process was unlocking or activating the knowledge within the network. Aspects of trust between network members, as discussed in the previous category, and related willingness to share knowledge influenced this process.

The second step consisted of providing access to external sources of knowledge, through support actors such as veterinarians, feed advisors and sharing relevant scientific knowledge. The way in which scientific knowledge was brought to the network varied. In several cases the facilitator brokered expertise through inviting a scientist or advisor to discuss a specific topic of interest; some facilitators shared scientific journal articles with the network members; and other facilitators summarised an area of science into short, practical summaries for their network. The facilitators observed that in general networks valued gaining scientific information that could be applied on-farm. In some cases, the scientific knowledge required by a network to progress was not available. For example, several networks were interested in exploring the use of LED lighting and its effect on productivity and disease prevention: scientific knowledge was limited to what a chicken can see in terms of spectra and frequency, rather than commercially applicable information on the impact of LED lights on hen behaviour and production, although anecdotal evidence from farms which had already installed LED lights was shared with the network.

The facilitators noted that having a common problem did not automatically lead to innovation and that networks needed to have a *collective motivation to innovate.* The facilitators perceived this collective motivation emerged from generating an innovative idea that is practical, feasible and has a clear benefit. For example, several networks in the UK assessed the feasibility of their idea by setting out potential scenarios and looking at areas of financial gain, and the *internal legitimacy of the network* i.e. the collective confidence of the network's ability to take the idea forward and innovate with a shared belief that the outcome would be valuable and credible. The process of practice-driven innovation in which farmers are empowered to develop their own solutions was not always valued equally by the network members within the same network. Sceptics within some networks made others also doubt in the process and their capacity to realise it.

A particular challenge for the facilitators was to move the networks from the stage of problem definition and idea generation towards generation of innovation itself. The facilitators listed that *practical engagement* of network members and providing them with opportunities for joint learning, through for example testing their innovative idea, was an important factor to enable and enhance innovation. The networks tackled a range of problems and challenges through the testing and development of different types of innovative ideas. Alongside technical 'hard' or product innovations, e.g. new type of litter material to reduce stress and encourage natural behaviour, new designs of trolleys to aid depopulation, or the use of alpacas in organic systems to reduce predation; a variety of 'soft' innovations emerged, such a new way of marketing hen meat to enhance its value and new relationships between farmers and production chain actors. Most ideas tested were incremental, some were more radical, however, in terms of building the capacity of the networks to innovate both were equally valued and important.

Effective facilitation was listed as an important factor enabling practice-driven innovation. The facilitators indicated that facilitation of practice-driven innovation processes was a challenging but critical factor in creating the capacity for achieving innovation, or moving towards innovation within networks. Innovation facilitation was seen as substantially different from the role of providing technical support to farmers. The facilitators described their role as

essentially network brokering, guiding the networks through the innovation process, developing connections and linking networks with actors who had similar interests to the network, plus monitoring and reflecting on the functioning of the network to determine relevant and specific support and action. The role of the facilitators was not static, and varied between networks, the context in which a facilitator operated and the step in the innovation process (van Dijk *et al.* 2017 in press).

3.2 Conditions for successful application in practice

Final discussion during the FGD revolved around external factors enabling practice-driven innovation. The facilitators listed four external factors for successful implementation in practice. In essence, these are: *external legitimacy* of the process and results, access to *external resources and support*, *legislative and regulatory support* and flexibility or '*space*' within the production systems and supply chain.

External legitimacy of practice-driven innovation (how innovative practices are recognised and given credence beyond the networks from which they were derived) was seen as an important enabling factor for most networks. This was indicated by, for example, the willingness of support actors to engage in the process and availability of funding sources to support this type of innovation.

Access to external resources and support in terms of external actors bringing in their knowledge and experience, played an important role in speeding up the practice-driven innovation process. Support actors were invited by network members directly or invited by the network facilitator, and these actors generally supported the networks on a voluntary basis. Some came in on an ad-hoc basis to provide specific knowledge, others supported the network for a longer period; for example a veterinarian supported a network during data collection in The Netherlands. The project provided the networks access to a small seed fund to help cover their costs of meeting up and trialling. Although this was a relatively small amount of money, 11 out of the 19 networks applied for this seed funding. The facilitators indicated that the availability of this seed funding provided motivation for the network to innovate, as the network members felt their ideas were worth investing in. This also increased the internal legitimacy of the network. The seed fund provided a successful model for innovation support as it was experimental, bottom-up and facilitated. Facilitators further supported the networks to find other funding sources. For example, one of the networks in the UK, in collaboration with a bio-tech company and a food processor, has planned to apply for a larger amount of funding from Innovate UK to finance their trial. It was also felt important that there was need for *Legislative and regulatory support* from the relevant authority to support proposed changes in practice. This was particularly relevant for requirements relating to beak trimming laying hens.

During the FGD the facilitators discussed the differences within the laying-hen sector in the project countries, in particular the integration of the supply chain within the sector and how this affected innovation. Variation in governance of farmers through their production contracts enabled or hindered practice-driven innovation. For countries with highly integrated supply chains in the laying-hen sector, such as the Czech Republic and Spain, the formation of any networks was rare. Networks of organic farmers in the UK and Sweden were constrained by organic regulations. Other producers were financially constrained by to tight financial margins in their contracts. The facilitators indicated absence or presence of flexibility or '*space'* for innovation within laying-hen production systems as well as in the supply chain was a major factor enabling or hindering practice-driven innovation.

4. Concluding remarks

By focusing on the dynamics of practice-driven, grass root innovation and its articulation with existing science and market-driven actors, this paper explored the factors enabling (and hindering) practice-driven innovation. This paper is part of a larger piece of research including FGDs with networks members to validate these initial results. The factors identified by the facilitators provide initial insight in the enabling (and hindering) factors to practice-driven innovation; generalisation of these factors is however limited by the fact that practice-driven innovation processes are network- and context-specific. The nature of individual innovation processes is contingent upon the capacity of the facilitator and the networks themselves and influenced by a wide variety of factors including the structure of the poultry sector, market forces and the wider Agricultural Innovation Systems in each country. Furthermore, a large diversity in progress and functioning of the innovation networks within as well as between countries was observed. Nevertheless, from this on-going research, we draw a number of key parameters for the emergence of effective practice-led innovation:

a. Facilitation: the key role and function of a facilitator or coordinator,
b. Embeddedness: the integration of the network and its members within the relevant industry sector,
c. Multi-Actor engagement: the accessibility and involvement of support actors from industry, from science and from technical actors,
d. Legitimation: the acceptability of the proposed innovation and the risk involved in pursuing any necessary changes in practice,
e. Capacity and Knowledge Building: the importance of horizontal knowledge development and sharing alongside access to external expertise,
f. Experimentation: the readiness to go beyond the confines of existing practice to challenge ways of doing,
g. Pathways of up-scaling: mechanisms for the diffusion and wider acceptance of tried and tested innovation.

The facilitators listed trust between network members and existing relationships as enabling factors. Further mapping of intra-network relations, both geographically and in terms of the nature of the relationships within networks, will provide greater understanding of the relational impacts on practice-led innovation and how this may be enhanced or hindered by network dynamics. The use of an intermediates was key in getting the networks mobilized but it is currently unclear how much control, either directly or indirectly, these intermediates had on the subsequent innovation process. In several networks the intermediate, for example the egg-packer, was an integral part of the network and this raises questions on how this influenced network dynamic in terms of power relationships (Faul, 2015) and whether some of the supposed farmer-led networks were in fact industry-led.

An aspect not directly addressed by the facilitators, inevitably influencing practice-driven innovation, was the institutional context in which this project was implemented. The project was lead and implemented by academic institutes in five different countries. As indicated by Klerkx *et al.* (2017) these institutions all have '*country-specific histories and path-dependencies'* leading to a different starting position for implementing this type of research project. This was clearly evident in, for example, the differences in the length of time required for mobilization of the networks in the different countries. The facilitators experienced challenges in promoting a practice-driven approach to innovation in a research setting where the institutional culture was inherently top down, where innovation was seen as a linear process and where incentive and administrative structures were absent or often not sufficiently flexible to support a practice-driven process. Further research work will be

conducted as part of this project to understand how this enabled or hindered the practice-led approach.

This paper has provided an original, investigative analysis into innovation networks as a mechanism for achieving greater sustainability in agriculture. As a particular form of multi-actor, project-based innovation group, there is a growing number of such schemes currently in operation, including the 'Innovative Farmers' scheme in the UK, the 'Monitor Farms' scheme in Scotland, the Stable School scheme in Denmark (Vaarst *et al.*, 2007) along with the rapidly expanding number of 'Operational Groups' formed the European Innovation Partnership for agricultural productivity and sustainability and funded, within each Member State under the EU Rural Development Programme (EIP-Agri, 2016). The Hennovation networks, along with these other examples, collectively offer a novel and promising approach to stimulating and developing innovation in agriculture and responding to the traditional separation between science and practice. Nevertheless, while there is considerable energy for and engagement in these forms of innovative practice at the individual and local level, and often high levels of support from scientific and industry actors for specific schemes, the mechanisms for wider institutional and financial support are often insufficient or unclear. Moreover, as this current paper reveals, while individual examples of successful facilitation and innovation can be documented, clear frameworks for assessment and validation have yet to be fully explored.

At the time of writing this paper several the networks were still in the process of trialling or testing their innovative ideas. Currently we can conclude that networks can be an effective mechanism for generating innovation (or a certain kind of innovation) at the 'on-the-ground' level of farming practice. The kinds of innovation generated through practice-led networks are different from the kinds of innovation emerging from science and more traditional top-down pathways of innovation delivery but can be provide practical evidence-based technical solutions valued by farmers.

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