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Farmers doing it for themselves: how farmer-inventors are frustrated by their interactions with the Agricultural Knowledge and Innovation System

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Abstract: *Notwithstanding recent policy commitments to formally involve farmers in innovation through initiatives such as the European Innovation Partnership (EIP-AGRI), the traditional perspective of the policy and academic literature in Europe has been that agricultural innovations are provided by others for farmers to adopt. In this context there has been relatively little research on the approaches of farmers who independently invent useful products and processes for themselves. This paper presents an analysis of Irish farmers' inventing processes as a form of user innovation, using data generated from in-depth interviews with farmer-inventors and semi-structured interviews with key informants from agricultural organisations. The farmer-inventors mostly use tacit knowledge and practical skills to create their inventions with the objective of increasing efficiency as a means to improving family farm viability. Farmer-inventors with entrepreneurial intentions were less inclined to share their ideas freely and described financial and temporal constraints in commercialising their inventions. The Agricultural Knowledge and Innovation System (AKIS) concept was used to frame an analysis of farmer-inventors' interactions with innovation support organisations from the perspective of the farmers themselves. This allowed appraisal of the Irish AKIS' support of farmer-led innovation relating to the positioning, visibility, and representation of farmers' knowledge, inventions, and networks. This study contributes new knowledge about user innovation in European agriculture as EIP-AGRI co-production structures become established. It is proposed that farmers are a hitherto underappreciated source of independent knowledge and inventions in agricultural development and are poorly supported by AKIS institutions.*

Keywords: *tacit knowledge, user innovation, farmer-inventor, Ireland, Agricultural Knowledge and Innovation System (AKIS), family farm.*

1. Introduction

1.1 Farmer-inventors

In 1986, an Irish farmer invented a feeder that served warmed cow's milk, on demand, to calves after weaning. The calves' health and weight gain improved and, after testing the feeder on three farms, the farmer took it to his dairy co-op and government agencies. They either ignored his evidence or told him to test the feeder with a larger sample under scientific conditions (Shutes, 2003). Shutes concluded that the farmer-inventor's evidence was wrongly rejected due to an imbalance of power and also because the feeder offered farmers the means to pursue a beef and dairy dual-income strategy, contrary to European and Irish policy incentivising specialised milk production at the time. The farmer subsequently gained a patent and successfully manufactured the feeder proving its wide applicability. This paper asks: are farmer-inventors better supported by AKIS institutions in their innovation processes today?

Since Shutes' study, "user innovation" (von Hippel, 2005), whereby "users create and modify products and services to serve their own needs" (Flowers et al., 2010) has been a growing area of research in the business literature. User innovations often result from an unmet need and the user-innovator's "direct and repeated personal experience with a problem" (Lüthje et al., 2005) for which there is no appropriate market solution (de Jong and von Hippel, 2008). The primary benefit therefore is the satisfying of self-identified needs (Lüthje et al., 2005), while further reputational and economic benefits arise from the distribution of the innovation (von Hippel, 2007). De Jong (2016) proposes three options for the diffusion of user innovations: free sharing, whereby other users copy or adopt the innovation without charge; user commercialisation, by setting up a new enterprise to market the innovation; or, following a "lead user process" (Lüthje and Herstatt, 2004), the innovation is taken up by a firm that produces it for the market. Commercialisation of an invention may well be an attractive proposition for Irish farmers, 63% of whom have economically unviable farming businesses (Hennessy and Moran, 2016), with many relying on off-farm income.

While there have been no detailed studies of farmers as user-innovators, Hoffman et al. (2007) found farm equipment to be the most prevalent area of farmers' inventing. A survey of Dutch small and medium enterprises found 7% of respondents were farming-related businesses, of which 43% reported some type of user innovation in the last three years (de Jong and von Hippel, 2008). The authors reflect that in farming "there is more innovation going on ... than policy makers are aware of". Although farmers' inventions are often ignored by agricultural researchers, "on the grounds that they are merely incremental, non-technological or not appropriate" (EU SCAR, 2012), recent European policy commits to formally involve farmers in the co-production of knowledge and innovation. The European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI) was launched in 2012 and aims to connect agricultural research with farm practice in interactive research and innovation processes (EU SCAR, 2013). It defines innovation broadly, potentially opening up the AKIS to firm-led open innovation, which can involve users (Bogers and West, 2012), and user-led innovation, as described above. However, the most recent EU strategy on agricultural research and innovation (European Commission, 2016a) views farmers as co-creators, with others, of knowledge, rather than active problem solvers and knowledge creators in their own right.

1.2 Agricultural Knowledge and Innovation Systems

Notwithstanding these developments, improvements in European agriculture have been traditionally understood as arising from an Agricultural Knowledge and Innovation System (AKIS), with innovations provided by others for farmers to adopt. Even in contemporary debates, despite an extensive literature on the value of farmers' knowledge (see Maye et al., 2014; Burton and Paragahawewa, 2011, among others), organisations in the AKIS are said to "act upon the knowledge of farmers and rural actors and generate innovations" (EU SCAR, 2012). The mandates of EU programmes such as Horizon 2020ⁱ, however, place emphasis on the distinction between the involvement of farmers as 'stakeholders' (consultees) and as 'actors' (partners) in the innovation process.

Conceptualisations of agricultural research, advice, and education systems have evolved significantly since the 1960s (Röling and Engel, 1990, and others globally), from the Agricultural Knowledge System technology transfer model to the current AKIS networked approach for mutual learning and innovation between farmers and other actors (EU SCAR, 2012). Drawing on research in Europe, this paper applies the AKIS model, which is fundamentally a systems concept, to analyse and discuss farmers' knowledge and inventions, and their interactions with AKIS organisations.

One approach to the systems concept, which features in some of farming systems literature, views the system as an "objectively describable" entity (Ison and Schlindwein, 2015). This paper uses the systems concept as an epistemological device, i.e. "a way of knowing about the world" (Ison and Schlindwein, 2015). It follows therefore that farmers' knowledge and skills, the inventions that embody them, and the networks in which they are (re-) created, (re-) produced, and (re-) distributed are socially constructed (Howells, 2002). Correspondingly, conceptualisations of the AKIS are contextually sensitive with the components, connections,

and boundaries of the system defined according to the perspective of the systems practitioner. Lane and Oreszczyn (2013) find the AKIS overall to be comprised of “organisations and individuals, linked and interacting through networks ... creating, sharing, and using different types of knowledge”. While many AKIS models include farmers, their status is far from clear, and farmers’ own knowledge networks are often absent from earlier models (EU SCAR, 2012, 2013).

The invisibility of farmers’ inventions, and the tacit knowledge and practical skills they embody, suggests a knowledge hierarchy may be at work. Tovey and Mooney’s (2006) sociological study of European rural development finds tacit knowledge to be “created, shared, and exchanged” in place-based social relationships, presenting a challenge to the “hegemonic scientific culture” (Tovey and Mooney, 2006) that dominates agricultural research and environmental governance regimes. Tovey (2009) suggests farmers’ tacit knowledge is seen as inferior by regulating institutions that “invoke and thus reinforce’ a boundary between science and other forms of knowledge”. Tovey and Mooney (2006) also found that some researchers held a view of rural people as being deficient in their understandings of science, technology, and business: “the issue of rural ‘knowledge deficit’ can be re-interpreted as an incapacity of existing managerial knowledge to make such interconnections in a non-hierarchical way”. It is not surprising therefore that farmer-inventors find spaces outside the AKIS in which to carry out their inventing activities.

Farmers’ networks offer formal and informal opportunities for the exchange of knowledge and practices and Pelling et al. (2008) describe a “shadow space for social learning ... that lies outside of but interacts with formal institutions and relationships”. This paper argues that it is within these shadow systems that many farmers demonstrate their knowledge and skills in the production of their independent inventions, largely invisible to AKIS organisations. Yet, farmers’ inventions are not entirely hidden. There are farmer-run inventing networks (e.g. L’Atelier Paysan, France) and repositories (e.g. Practical Farm Ideas magazine, UK; FarmHack website, USA), but nothing comparable in Ireland as yet. Mechanisms that elicit farmers’ inventions include competitions (Macken-Walsh et al., 2012), innovation circles (Wu and Pretty, 2004), and programmes such as PROLINNOVA (Wettasinha and Waters-Bayer, 2010) or the Honey Bee network (Gupta, 2006).

2. Context and Methods

2.1 The Irish AKIS

In the PRO-AKIS projectⁱⁱ inventory of the Irish AKIS, Prager and Thomson (2014) identify four groupings of agricultural organisations that interact with farmers (public sector; private sector; farming based organisations; research and education), plus the agricultural media. Substantial elements of the Irish AKIS are found within a single organisation, *Teagasc* (Ireland’s Agriculture and Food Development Authority). Unique in Europe, *Teagasc* is responsible for integrated agricultural research, education, and extension services. While *Teagasc*’s central role gives the Irish AKIS coherence, it has been suggested that the increasing number of private extension providers requires improved knowledge flows throughout the AKIS (Prager and Thomson, 2014).

Farmers’ involvement in knowledge exchange is facilitated by *Teagasc* through farmer discussion groups; farm walks and demonstration farms; joint-industry programmes; and joint programmes with farmer co-operatives (Prager and Thomson, 2014). Many of these initiatives are designed and driven by policy schemes, with delivery through private advisers in addition to *Teagasc*. However, terminology such as ‘knowledge transfer’ (KT) continues to prevail in how these initiatives are normatively understood. The Food Wise Agri-food Strategy (DAFM, 2015) focuses on knowledge transfer from ‘experts’ to farmers, with discussion groups viewed as a means to “provide access to up to date research and information” (DAFM, 2015), with farm viability depending on “adoption of the latest production technologies and processes” (DAFM, 2015). EU-funded peer-to-peer discussion groups, administered by Ireland’s Department of Agriculture, Food and the Marine (DAFM), are

called 'Knowledge Transfer Groups'. The KT groups, many of which were organically established by farmers and in operation for decades, are funded on the condition that they undertake discrete projects, often more oriented to the assimilation of 'expert' knowledge than stimulating farmers' knowledge exchange and creativity. 'Knowledge Transfer' is also the formal title of *Teagasc's* advisory services and, although the traditional approach to designing extension has involved farmers as 'stakeholders', some extension programmes were originally farmer-led (e.g. farmer discussion groups and demonstration initiatives). More recently programmes have been co-designed, in a multi-actor approach, where farmers have leading roles (Macken-Walsh et al., 2017a; Macken-Walsh et al., 2017b). Operational Groups (OGs) are currently being established under EIP-AGRI which bring together farmers, advisers, scientists, and businesses to find practical solutions for specific problems. These include a number of farmer-led initiatives and the practical outcomes may include inventions.

Such approaches lead to relational or 'soft' skills for authentic transdisciplinary and multi-actor collaboration with farmers being increasingly emphasised in organisational culture (Macken-Walsh, 2017). However, cultural transitions from valuing 'hard' technical skills to also valuing 'soft' participatory skills are not unproblematic, not least because of the traditional masculinised cultures that prevailingly characterise agricultural organisations worldwide (Macken-Walsh, 2017; Cush and Macken-Walsh, forthcoming).

Since Shutes (2003), there has been little research on the approaches of farmers who independently invent products for themselves and the subsequent sharing or commercialisation of these products. Equally, this type of farm-level knowledge creation is neglected in conceptualisations of the AKIS. This paper uses the AKIS model as an analytical tool to frame the farmer-inventors' perspectives of their interactions with farming research, advice, and innovation support organisations and critically examines issues such as knowledge status, understandings of innovation, and relational exchanges between farmer-inventors and AKIS actors.

2.2 Methodological approach

This study explored how farmers' knowledge and inventions, understood as arising from situated social structures, manifest in a country with a well-established AKIS. Data was collected during 2014 and 2015. The research design involved an in-depth interview method known as the Biographic-Narrative Interpretive Method (BNIM) which explores personal histories, lived situations, and experiences (Wengraf, 2001). This lightly structured qualitative interview allowed the five farmer-inventors who participated to express themselves in their own words and to put forward insights that may not occur to the researcher to include in a more structured questionnaire. BNIM has been used to explore farmers' situated knowledges and subjectivities, intergenerational and community influences (McDonald et al., 2014). Biographical methods are said to "[reconnect] social policy with lived experience" (Chamberlayne, 2005) and, given the highly policy-driven nature of farming, afford access to farmers' narratives on their interactions with AKIS organisations.

The practical aim of BNIM is to encourage interview participants to describe in detail the important experiential factors influencing, in this case, their inventing activities, motivators, and decisions, from their own perspective. The first, unstructured, phase of the interview means that farmer-inventors' "subjective perceptions, viewpoints, opinions, knowledge types etc. and their life histories" (Macken-Walsh et al., 2012) are encouraged to be expressed in a way that is not limited by the researcher. The BNIM method involves up to three interview sessions. In the first, a single question is asked to induce the participant's narrative, to which the researcher listens and does not interrupt. In the second session the researcher uses the participant's own phrases, chronologically, to ask for more detail about experiences mentioned in the narrative that are of particular relevance to the research question. A third sub-session is optional and only if there are outstanding questions following the two previous sessions.

The approach to participant selection recognised that only some farmer-inventors take their inventions into the public domain and selection criteria were based on the visible level of their

involvement in invention competitions or related media. Participants were identified through researcher networks, *Teagasc* advisers, and at agricultural shows where they were taking part in invention competitions, see Table 1. This meant that factors such as age, gender, or farm size were not part of the selection criteria.

Table 1. Farmer-inventor selection criteria

Participant pseudonym	Level of engagement	Evidence
Francis	Local and national engagement	Entry to county and national invention competitions.
Alan	Global engagement	Sharing of inventions through <i>Practical Farm Ideas</i> magazine.
Declan	Local and national engagement	Entry to county and national invention competitions.
Mark	Local and national engagement	Entry to county and national invention competitions.
Kevin	Local engagement only	Shares inventions locally.

The five participants are all active inventors with multiple inventions, male, and (but one, Alan) conventional farmers. Two are retired from farming (Francis, Declan), with the rest involved in a range of farming enterprises, including dairy, arable, and beef. Only one went beyond school education or received any formal agricultural training (Alan). All are or had been active in farming organisations. Three have tried to commercialise an invention, with two of the farmer-inventors holding patents (Francis, Declan). Two prefer only to freely share their ideas with farming peers (Alan, Kevin). The interview sessions ranged from one hour to five hours face-to-face, with additional ethnographic-type exercises involving the farmer-inventors showing their inventions (completed and works-in-progress), personal archives (photos, videos, newspaper cuttings, trophies etc.), workshops, and yards.

Although the focus of this paper is farmer-inventors' experience of innovation support organisations, the study included interviews with five key informants (KIs). They were selected purposively for their organisation's interest in farmers' inventing and their involvement either in running invention competitions (three participants) or through their long-standing contact with farmers in their roles as farm advisers, see Table 2. Only a small number of Irish farmers take their inventions into the public domain and, in order to protect their identities, it is not possible to offer more detailed biographies of either the participants or KIs.

The KIs were interviewed using a semi-structured approach to allow exploration of the institutional landscape of agricultural innovation in Ireland and offer an institutional counterpoint to the farmer-inventors' perspective. Originating in ethnographic studies, a key informant (KI) is well-informed (Marshall, 1996) within "a certain cultural domain" (Tongco, 2007), and it was important to be aware of the influence of the KIs' own framing of agricultural innovation, their formal training and experience of farmers and farming. Such framings would be relevant to their understandings and activations of the knowledge hierarchy in their interactions with farmer-inventors.

Table 2. Key informant profiles: level, organisation type; role; number of participants in the role

Level, organisation type	Role	Number
Local/county - farming-based Non-Governmental Organisation	Organisation of county invention competition, farming business adviser.	1
National – public sector	Organisation of national innovation competition, provides business advice.	2
National – public sector	Provide farming advice to clients.	2

The data were analysed using an inductive thematic approach, informed by user innovation theory (von Hippel, 2005) and framed using the AKIS conceptual model, with the aim of developing a “coherent, thick description” (Holliday, 2002). Participants were involved more extensively by offering their comments on their own interview transcript as well as the preliminary research findings.

3. What do Irish farmers invent?

The outputs of the user innovation process may be physical or digital and have been studied in a range of sectors, (Shah and Tripsas, 2007), but not agriculture. The farmers interviewed here were all inventors of tangible artefacts. Studies in the innovation literature (Strumsky and Lobo, 2015, among others) find that radical innovations are rare, with re-combinations and modifications of existing technologies the dominant source of patentable inventions.

Over three quarters of farmers in Ireland use tractors (European Commission, 2016b) and unsurprisingly the participants’ inventions were often tractor-associated. Some were mechanical implements attached to the front or back of the tractor, drawing power from the engine using the power take-off shaft, involving hydraulic systems. These included: combined baler and wrapper, front loader extension, post driver, tilting land leveller, and a combined harrow and drill. One farmer invented two self-powered mobile machines for turning turf and yard scraping. Non-mechanical tractor-related inventions were a working platform and gearbox bearing remover.

Participants’ livestock-related inventions were also mechanical and non-mechanical. Mechanical inventions included a calf feeder, dosing system, and moveable poultry house. Non-mechanical livestock inventions were described as a clean water system, castration guard, crush retaining bar, and calving aid. No process or ICT-based inventions were mentioned, however the list here is likely not exhaustive. The diversity of inventions described by the farmer-inventors shows not only the creativity involved in meeting a range of farming needs, but also their farming, mechanical, electrical, materials and workshop knowledge and skills. The prevalence of mechanical inventions to meet the self-identified needs of the farmer-inventors is at odds with the promotion of digital technologies by AKIS organisations (Teagasc, 2016).

4. Farmer-inventors’ perspectives on their interactions with AKIS organisations

4.1 General farming needs

Farmer-inventors interact with AKIS organisations in connection with their daily farming needs and, separately, regarding their inventing activities. All the participants have sought advice from agricultural advisers and other professionals and taken part in extension activities, yet overall they are critical of advice, research, and regulatory bodies. They are also concerned about the impact of national and EU policy on their prospects in a global market.

Agricultural advice is generally viewed by this cohort of farmers through a sceptical lens. The farmer-inventors cite: inappropriate advice regarding native cattle breeds (Alan); reversals in advice on arable methods (Kevin); and advice influenced by financial interests, such as input suppliers, described as “pushing chemicals” (Kevin). This leads to a lack of trust in professional advice offered by private and public AKIS institutions, such as *Teagasc*, Animal Health Ireland, and local co-operatives. The scepticism that results from this lack of trust is compounded by the financial risk carried by the farmer:

“they make your calculation, and it looks wonderful on the paper, and then one of the factors changes and the farmer is down the drain and pays the bill and carries the responsibility” (Alan).

The farmer-inventors have mixed views of extension activities, acknowledging good ideas taken from farm walks and international visits, yet one found that organic talks were focused on economic benefits, rather than good farming practices:

“Do you know what they were talking about? Profit. There was not one word about soil or micro-organisms, or anything important to a real organic farmer” (Alan).

Some of the farmer-inventors were wary of the vested interests involved in agricultural research, linking research findings to funders’ agendas, and suggesting that some research is against farmers’ interests, e.g. *Teagasc*’s research into artificial meat that would compete with farmers’ livestock enterprises (Alan).

Regarding regulatory organisations, the participants, in common with many small businesses, have little positive to say. They describe a ‘tick box’ culture that does not address important issues of food quality assurance (Declan, Alan), general red tape and form filling (Mark, Alan, Declan), and inspectors who cannot justify their requirements (Alan). Regulatory obstacles to income diversification, e.g. electricity micro-generation, were mentioned (Francis, Alan). Those who have experience of the media, either as inventors or campaigners, are generally positive, except one (Alan). He found his views were sometimes misrepresented and was pleased to receive a copy of his interview transcript. They are also concerned about Irish farming remaining competitive in a globalised market and are critical of past and ongoing policies relating to the setting up of co-operatives (Declan), small family farms (Kevin), and cheap food (Kevin, Alan).

Research conducted in Ireland and Europe has consistently found that family farmers are judicious in how they evaluate external advice and are often wary of it, displaying “both persistence and adaptation” in their resilience strategies (Grubbstrom et al., 2008). Shutes (2003) describes pioneering farmers who actively evaluate external knowledge with some, as a direct result of their social status in their communities, developing solutions (including inventions) to common problems. The user innovation literature similarly finds user-innovators rely largely on their existing knowledge (von Hippel, 2007), generally from work or hobbies, with a small number acquiring new knowledge to develop their innovation (Lüthje et al., 2005). These farmer-inventors are actively critical of the advice originating from AKIS organisations suggesting that the ‘knowledge transfer’ process does not always meet unquestioning acceptance.

4.2 Farmers’ inventing and AKIS organisations

Farmers’ engagement with AKIS organisations in connection with their inventing was described in two ways: seeking formal validation for their inventions, generally through patents and agricultural show prizes, and, second, trying to get advice and support for commercialisation. The farmers are generally dissatisfied with the prevailing arrangements in AKIS organisations relating to their inventing activities.

4.2.1 Seeking Validation from Formal Organisations

All the farmer-inventors described getting feedback from trusted peers in their knowledge networks during the development of the invention and getting formal validation for their

inventions is not always straightforward, with the knowledge hierarchy that places scientific knowledge above their tacit expertise believed to be in play.

First, concerning patenting, which is the formal recognition of inventions (and the invention process), all the farmer-inventors were aware of the need to protect their Intellectual Property (IP), with two having achieved patents. For one it conferred legitimacy:

“I have a patent from the British Patents Office for that machine, so I can legally call myself an inventor” (Declan).

The other found the cost of maintaining a patent to be a burden (Francis). For the others the patent process appears to be expensive, time consuming, and, probably, ineffective at protecting their IP (Mark, Alan). The ease with which patents can be breached, for example through minor changes to the design, leads one (Mark) to view patents as a waste of money, because protecting a patent involves High Court action which is beyond most farmers' means. However, one farmer-inventor welcomes defensive publication of designs (Strumsky and Lobo, 2015) as a subversive act of sharing for the greater good:

“if you publish it once, nobody else can patent it ... everyone can copy it” (Alan).

There is also a perception that some of their ideas might be insufficiently novel or too simple to qualify for a patent (Alan, Kevin). One AKIS actor (KI 5) views the farmers' inventing as a hobby, rather than an entrepreneurial activity, suggesting farmer-inventors are not taken seriously by the AKIS actors.

With regard to invention competitions, three of the participants (Francis, Declan, Mark) are regular agricultural show entrants and have won prizes, which encouraged one to persevere with his inventing:

“we won a prize for £250 and we thought that it was great altogether ... it just drives you on to go that little bit farther” (Mark).

While there is prestige attached to winning, one participant suggests that, as the agricultural show is the only opportunity to present an invention and get wider feedback, it puts farmers in a difficult position:

“his hand is put behind his back, because you either bring it here and show it or ... you leave it at home gathering dust” (Mark).

He goes on to suggest that farmers who lack the confidence, time, or money to attend the show may never exhibit important inventions.

Once entered into the show, the awarding of a prize follows an assessment of the invention and the farmer-inventors are somewhat critical of the judging process, with one questioning whether judges' qualifications are always relevant to the task:

“They always throw in an engineer ... Is it an electronic engineer, is it an electrical engineer, is it a technical engineer, is it a mechanical engineer, is it a service engineer? ... If you have a guy that's specialising in one thing, the product might be for something completely different” (Mark).

Another was angry that his invention had not been examined to his satisfaction by the judges:

“This is stupid ... I have something there ... and I would need somebody that would know something about what it's about ... to sit down for at least an hour ... to go through ... what I am doing” (Declan).

However, the social aspects of the agricultural show, the chance to meet other farmer-inventors and build networks are as important as winning a prize for all the farmer-inventors.

The farmer-inventors are also aware that their tacit knowledge is not given as much weight as that of the formally educated by formal AKIS organisations. They understand the limitations of their knowledge and regret the lost opportunities for fruitful interactions:

“I’m just a Joe Soap, a fellah from national school ... how can Professor whatever-his-name-is ... how can they come down to my farm? ... I mean, you go up a ladder ... you don’t come down ... I am disappointed with that, because I think there is a loss there” (Declan).

Contextual knowledge is also thought to be undervalued:

“you get someone from the city that comes over to do something in [this area], but they don’t know nothing about [this area] ... you need a certain amount of local knowledge” (Mark).

This awareness of the dominance of formal learning extends to the farmer-inventors’ approach to inventing. One trusts his own judgement, which is born of experience:

“[He] tells me that there’s all sorts of stresses and strains and calculations that I should make, but I don’t make them ... you have an eye for that sort of stuff ... you’ve an idea what strength will work” (Kevin).

The recognition of the value of practical expertise extends to a direct comparison with agricultural researchers:

“I have no doubt that them guys are a way better at what they’re doing ... But it is possible, because I have more contact with bits and pieces on the practical side of it, I am in a way better position [to create new products]” (Declan).

Not all farmer-inventors get it right and both the farmer-inventors and KIs gave examples of inventions that do not work well.

In seeking validation for their inventions, the farmer-inventors recognise that their tacit knowledge gives them certain advantages over those with formal learning with regard to the practice of inventing, while user innovators’ trial and error design approaches are said to contrast with more formal processes in firms (von Hippel, 2005). The superior status of formal knowledge is thought to be unfair, being embedded in the structures farmer-inventors must negotiate, such as the patent process and invention competitions. This could be said to reflect a system-wide knowledge hierarchy in which tacit knowledge, lacking formal validation, is afforded the least status (Tovey and Mooney, 2006). It is not surprising therefore that farmers’ own innovations are often deemed insignificant or inappropriate by a system predisposed to ignore farmers (EU SCAR, 2012).

4.2.2 *Getting support to commercialise inventions*

All of the farmer-inventors acknowledge that they need help to take their inventions forward as they lack some of the knowledge, skills, and resources required:

“You need someone to ...stand beside you ... we need someone’s support” (Francis).

The farmer-inventors find that the support on offer does not meet their needs:

“in real life ... there is no Dragons’ Den ... if I have an idea tomorrow I can’t go to Dragons’ Den in Tralee and say ‘I’ve an idea, lads, do you want to buy in?’ That’s not there” (Mark).

It is also difficult to find the help that does exist:

“a lot of the state bodies run their business the same way, in that if you don’t know which door to knock on they are not going to make you any wiser” (Mark)

and while there are a number of local and national agencies offering support, they seem to have overlapping responsibilities:

“in this area ... you’ve four or five organisations ... they’ve different names but they are all ... doing the same thing” (Mark).

There is also a lack of signposting and referrals between agencies, with organisations accused of guarding their territory (Declan), so that the farmer-inventors are not made aware of alternative sources of help.

When the appropriate organisation has been found, the criteria for accessing support can exclude some farmer-inventors:

“a lot of people are slipping in between, not big enough for this and too small for that” (Mark).

Once accepted for support, the farmer-inventors, who are already running farming businesses, find the training offered to be too rudimentary and not relevant to the production of artefacts:

“it was very basic and ... modelling it on some business ... a corner shop ... was of no real benefit to what we were at” (Mark).

Another found that there was no follow-up to the training and he was left “to go home with literature” (Francis) and raised expectations:

“I came home from that meeting in Thurles and I said ‘I’ll be a millionaire in no time’” (Francis).

When it comes to financial support, the farmer-inventors find that grants come with conditions that seem over-intrusive:

“I had a very good accountant, but he was not a chartered accountant, and, in order to draw down the 15,000, I had to move to a chartered accountant” (Declan),

and sometimes it is cheaper to Do It Yourself rather than comply with grant conditions:

“you have to comply totally with all their rules and regulations ... I looked into building a shed with grants. I could build it, actually, the way I wanted it cheaper myself” (Alan).

Apart from the burdens associated with grant conditions, the farmer-inventors find that financial institutions, such as banks, do not understand the seasonal nature of cash flow in farming and, for new small businesses, often require a year’s trading before they will lend any money (Mark).

The farmer-inventors also want help to negotiate the rules, regulations, and paperwork involved in taking an invention to the market (Declan, Mark), and in a way that is tailored to their business:

“[we] want to be asked ‘What do you need? ... We’ll give you an engineer to get it CE certified, or we’ll get you an electrician to get ... a safety statement on it’” (Mark).

As micro-entrepreneurs, the farmer-inventors are aware of the resource imbalances that exist between them and large businesses. One was offered a distribution deal for his patented invention by a large company but felt a lack of negotiating power:

“what they’d give me for making it wouldn’t ... pay at all” (Francis).

One farmer-inventor suggests the AKIS organisations are too close to pharmaceutical companies and closed to farmer-inventors’ ideas: “it was like a meeting of drug dealers” (Declan). Another finds the costs of product testing works to the advantage of large businesses:

“it’s to stop competition, because there’s very few of us who can come along with five million tomorrow morning if we come up with a product. So, it’s a way of curtailing the game” (Mark).

The participants believe that the AKIS organisations do not understand the challenges they face, in that the farmer-inventor does not have in-house skills and resources, such as marketing, accounting or technical design that a manufacturing company might. In this regard, one KI suggested that farmers’ inventions are “little ideas” (KI 3) and that farming inventions are more likely to come from engineering companies (KI 3). Similarly, those charged with rural development are not seen to support opportunities for the small number of jobs that these types of enterprises might provide (Mark) or to give priority to farming innovations (Francis). One KI suggests this may be due to changes in funding rules that do

not target agricultural innovation (KI 5), although another acknowledges the importance of agricultural machinery manufacturers to Irish exports and regional development (KI 2).

Given the significant time and money to be invested in commercialisation, the farmer-inventors want feedback on whether an invention has realistic potential in the market. They find such help is not available and believe it is because they are not taken seriously by the AKIS organisations:

“I keep making allowances for them, I keep saying ... They're not coming to me because they think that I am a bit way out here” (Declan).

Yet, one KI suggests that such independent verification is missing from many farmer-inventors' product development:

“you don't have the farmer coming into ... Enterprise Ireland or *Teagasc* and saying 'Look, I've got this idea, I want to try it independently on two farms' or going to the ... Farmers Journal test farm or the UCD farm ... and saying 'Lads, somebody road test that and come back to me when it's broken'” (KI 2).

Another KI acknowledges the difficulties faced by the farmer-inventors and suggests that cuts to public sector funding has resulted in reduced capacity to deal with non-priority issues, while the help that exists is increasingly ad hoc (KI 1).

Some of the farmer-inventors are also critical of the culture of the AKIS organisations, finding them to be hierarchical (Alan, Declan), inflexible (Alan), out of touch (Declan), and not showing leadership to support farmer-inventors' entrepreneurial activities (Mark). One farmer-inventor wondered whether the lack of interest in farmer-inventors is due to “arrogance or ignorance or ... jealousy” (Declan), yet they also acknowledged that individual staff in the organisations were generally helpful (Francis) and committed (Alan). One criticised the AKIS organisations as part of a self-sustaining rather than innovative system:

“once the system gets a hold of somebody ... they pretend to do a certain job ... and that isn't inventing new things. It's only looking after the system that's in place” (Declan).

The farmer-inventors seem to relish the opportunity to contest their subordinate role in the knowledge hierarchy and alleged neglect by the authorities:

“that's what the 'powers that be' think of farmers ... they're not really very worried about the farmers ... once we look after everybody else outside of the farm gate, let the farmers be fucking looking after themselves” (Declan).

Declan has adopted an outspoken role in his community over the years, which he has used to some effect to draw attention to the difficulties faced by farmers locally and wider. Another argues that AKIS organisations try to close down debate:

“they have a website, Facebook page, which dictates everything ... they have designed it so that you have really to look ... Is there any comments? Has anyone said something? ... They don't want to give people really a platform” (Alan).

Despite seeking validation from the AKIS organisations, the farmer-inventors are often unconvinced by the advice and support on offer, in connection to both their routine farming and inventing activities, and offer a detailed critique of the structure, functions and culture of the organisations. This willingness to challenge authority by this group of farmers seems to support Shutes' (2003) theory of “strong” farmers who use their social status to draw attention to problems in their communities.

This analysis of the interactions between farmer-inventors and AKIS organisations finds that the normative 'knowledge transfer' approach remains widespread, with innovation support organisations largely unaware of or poorly understanding the extent and nature of farmers' knowledge and inventing. That the AKIS organisations are not alert to or do not value farmers for either their knowledge of user needs or as innovators in their own right is suggested to arise from the knowledge hierarchy that prizes formal knowledge over tacit knowledge.

The lack of communication between what is happening at the farm level and Irish AKIS actors leads to gaps in the support offered to farmer-inventors and, being mainly interested in market-ready products, the organisations' criteria for help are often unsuitable for farmer-inventors. This contrasts with less developed countries where a renewed interest in farmers' research and participatory methods since the 1980s (Bentley et al., 2010) has led to recognition that the AKIS concept could potentially integrate grassroots innovation (Assefa et al., 2009). More recently, the Agricultural Research for Development (AR4D) approach is attempting to involve users earlier in the innovation process in order to improve the final product (Sumberg et al., 2013). While this move towards greater user involvement is a positive development, it does not fully recognise independent farmer-led innovation.

The user innovation literature emphasises the importance of tacit knowledge because users become conscious of their needs only after repeated experience of a problem, while firms' lead user processes involve those whose innovations would make commercially attractive products (Lüthje and Herstatt, 2004). User innovation theory, therefore, perhaps due to its foundation on economic theories of innovation, does not anticipate the constraining effects of the social and cultural norms that exist in AKIS organisations on their ability to engage meaningfully with farmer-inventors.

5. Conclusion

This paper sets out farmer-inventors' critical perspectives of their interactions with organisations in the Irish AKIS in relation to their everyday farming needs and their inventing activities. While sceptical of the advice provided, farmer-inventors recognise where they lack skills and resources to commercialise their inventions. When they seek help from innovation support organisations they find appropriate support, guidance and leadership is missing. They draw attention to shortcomings in the structure, functions, and services offered by AKIS actors, as well as the organisational cultures that do not seem to take them seriously. This suggests that the knowledge hierarchy that prizes scientific knowledge dominates the AKIS organisations to the extent that the farmer-inventors' tacit knowledge is not well understood. It is therefore difficult for the farmer-inventor to pursue a commercialisation strategy when their knowledge, skills, and networks are not recognised by key support organisations. As a result, chances for lead users to work with manufacturers for mutual benefit are missed, while inventions with commercial potential might never reach the market.

Overall, the findings indicate a continuing lack of trust in and frustration with AKIS organisations on the part of the farmer-inventors, while the AKIS organisations seem to hold farmers' knowledge and their trial and error design approaches in low regard, perhaps as a result of inconsistent policies on farmers' involvement in agricultural innovation at the European and Irish levels. A lack of appropriate brokerage means that farmers must seek out knowledge for themselves which is both burdensome and ineffective (Oreszczyn et al., 2010). Applying these findings more widely suggests that EIP-AGRI structures and processes must pay attention to the quality of, as well as the arrangements for, credible connections and brokerage of different types of knowledge between different kinds of actors representing different parts of the AKIS (Oreszczyn et al., 2010). Particular attention should be paid to the permeability of the AKIS boundaries to knowledge flows from farmers' shadow networks revealed in this study of the Irish AKIS. It may be that the organisation of the AKIS overall does not, in fact, facilitate farmers' independent innovation despite its purported aim.

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