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Exploring attitudes to technology adoption for cross compliance in Greek and Lithuanian farmers

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Abstract

The fourth agricultural revolution has started with an explosion of online, smart, digital technologies that are now available to support farmers to improve their operations is enabling opportunities for direct integration between agricultural and computer-based systems. However, the wide range of devices and applications available can be overwhelming and the farming community is showing reluctance to adoption of these new technologies. As part of an EU-funded, multi-partner research project we developed, in collaboration with farmers and other stakeholders, a novel on-line system that supports EU farmers and paying agencies to reduce the administrative burden of CAP's cross compliance record-keeping and inspections. During the co-development phase we interviewed Greek and Lithuanian farmers about their user needs in relation to the novel system and their potential adoption of this new technology. We analysed their qualitative responses and could identify two groups; 'Optimistic' and 'Reluctant' in relation to their use of novel technologies. In order to achieve up-take of new technologies within the European farming community, we considered these findings using the Theory of Planned Behaviour and concluded that focussing on the ease of adoption and peer usage would encourage the highest adoption rates as opposed to focusing on changing farmer attitudes.

Keywords

Digital Technologies, Theory of Planned Behaviour, co-development, technology adoption

Presenters Profile

Dr Yiorgos Gadanakis is an experienced analyst, proficient in data management, analysis and interpretation. His research focuses on the analysis of agricultural production systems in terms of technical and economic efficiency incorporating the relationship between environment and agriculture. His recent work on sustainable intensification and water use efficiency aims to improve the management of farm businesses and to reduce the environmental pressures generated at farm level. In addition, he has been engaged with a range of EU funded research programmes and has specialised in model development using both quantitative and qualitative analysis to attribute monetary values to certain aspects of sustainability.

Introduction

On-farm inspection is time consuming and expensive for member states (Pluto-Kossakowska et al., 2013). The high number of sites and farm businesses to inspect and so many regulations to comply with, infringements are frequently detected and in a recent EU audit between 20 - 29% of inspected farmers and businesses were found to have areas of non-compliance in the years 2009 - 2015 (European Court of Auditors, 2016). Even among farmers that are engaging with voluntary systems such as organic farming, there is a high rate of infringements, for example German and Italian organic farms were found to have a 15 % non-compliance rate (Gambelli et al., 2014) and farmers engaging with voluntary assurance schemes in the UK had an 11% non-compliance rate for animal welfare rules compared to 22% for farmers not involved in voluntary schemes (Clark *et al.*, 2016). With thousands of farms submitting applications for their Basic Payments to their paying agencies every year, the administrative burden of the rural payments system is high. As a result, EU governments are looking to alternative methods to reduce this burden. One method suggested includes the use of new digital technologies that deliver results derived from advanced machine learning and analysis of satellite images.

This article draws on a multi-country research project undertaken as part of an EU H2020 innovation grant aimed at reducing the costs of public administration of the CAP. The EU-funded RECAPi project – peRsonalised public sErvices in support of the implementation of the Common Agricultural Policy - proposed a methodology for improving the efficiency and transparency of compliance monitoring through a cloud-based Software as a Service (SaaS) platform to use the large volumes of publicly available data provided by satellite remote sensing and user-generated data provided by farmers through mobile devices (such as geo-referenced and time-stamped photos). A web-based portal would serve as a digital replacement for filling in mandatory paperwork required under cross compliance and would reduce the number of on-farm checks, with inspectors able to confirm compliance remotely by looking at remote sensed images of farmer holdings. Furthermore, the project sought to co-produce such a system with farmers, paying agencies and agricultural consultants with farmers contributing to the project in a series of user needs exercises, the first starting in 2016 with a series of semi-structured interviews. Through these interviews a theme began to emerge around farmer attitudes and abilities to adopting new technology. Socioeconomic barriers are important barrier to EU farmers – which can mean that supply side innovation is inadequate to drive adoption of new technologies (Long et al, 2016). Furthermore, the limited options in college education regarding digital agricultural technologies and their use in farming production systems and decision making are also a barrier to farm level adoption (Reichardt & Jürgens, 2009; Tiffin & Balcombe, 2011). Another barrier investigated previously is that social factors are often not considered when farmers are encouraged to adopt new technologies (Kutter *et al.*, 2011). Thus, these barriers were considered in the RECAP project and was the main reason for the user needs analysis work to ensure that the technology was suitable for all end users. The co-production approach ensured that all stakeholders were involved throughout the interactive, agile development phase. However, there is a much broader range of farmers who may end up utilising this platform and their potential adoption of this technology was investigated using Theory of Planned Behaviour approaches to changing behaviours. This article reports on the qualitative findings of the 2016 user requirements data collection phase of this project. It draws on the literature on attitudes and decision making with Azjsen's psychology-based Theory of Planned Behaviour approach.

Methods

The analysis presented here focuses exclusively on a series of semi-structured interviews conducted early in the project in 2016 with farmers in Greece and Lithuania with a user needs exercise to establish what web-based functionality and agricultural inspection areas were needed in a web-based compliance system. An interview protocol was developed to answer two main questions:

1. What were the farmers' needs for new technology in the form of an electronically based record keeping system to support cross compliance?
2. How keen were farmers to adopt this new technology and what potential risks and benefits did they foresee in the development and application of this new technology?

The first question focused on the farmer needs in terms of technical elements of a web-based record-keeping system to support cross compliance, i.e. do they have internet access, do they use personal computers or smartphones and how comfortable are they with these things. The second question is more theoretical and linked to Theory of Planned Behaviour. See Supplementary Information Annex 1 for full interview protocol.

The interview material was developed by the University of Reading team who trained the interviewing staff on interview technique, obtaining consent, respecting anonymity as well as the content of the interview. Interviews were conducted on-farm, with paying agency staff interviewing farmers who had been inspected within the last three years. Fifteen farmers in Lithuania and twelve in Greece were interviewed in their native language. The interviews began with a series of closed questions about the farm and the farmer's demographics followed by two series of semi-structured interviews with open-ended questions aiming to stimulate discussion about how farmers use technology and whether they were keen to see this change occur. The interview structure required that the interviewer had a good knowledge of the specific agricultural area and its relevant challenges.

The interviewers asked farmers structured questions about; their engagement and experience with technology, whether they had access to desktop PCs, laptops and/or smartphones, and whether they had access to a reliable broadband network on their farm. They also asked whether farmers kept electronic or paper records of their farm's activities as well as demographic information about themselves and their farm businesses. The interview then introduced pictures of key stages in the process of using satellite images in the not-yet-developed cross compliance platform. These images prepared the interviewees for a stage of semi-structured questions exploring problems they had encountered with cross compliance and solutions they could recommend. Interview length was variable and lasted between twenty minutes to one hour due to the unpredictable nature of semi-structured interviews and open-ended questions. Interviews were transcribed and translated by native speakers of Lithuanian and Greek at the University of Reading.

Qualitative analysis was thematic analysis of the sort described by Braun and Clarke (2006) where 'codes' are applied to excerpts of interview transcripts. It is a way of identifying recurring patterns in a heterogeneous dataset (in this case words freely spoken) where codes are short, summative words or phrases applied to a longer passage to capture something essential about the excerpt (Saldaña, 2013). The qualitative analysis was conducted by a first coder from the University of Reading team with the English translations using NVivo (NVivo qualitative data analysis software; QSR International Pty Ltd. Version 12, 2018). A second coder on the University of Reading team coded two interviews independently of the

first coder. They compared their codes, developed a code book together (as suggested by Saldaña, 2013) and the first coder underwent a second stage of qualitative analysis re-coding according to the jointly agreed code book. Quantitative responses to the closed questions were stored in Microsoft Excel (2013), with statistical tests completed in R (R Development Core Team, 2013).

Results

Although reluctance and optimism were the main themes that emerged reading through the differences in these two groups, the Technologically Reluctant Group was not universally reluctant towards all technology. They were optimistic about the opportunities that technology provides and generally thought they themselves were competent at using technology, but thought other farmers were less competent than they were. The Reluctant Group thought about technology in an abstract way rather than specific way and focused on barriers and the bureaucracy of their paying agencies.

Discussion

Theory of Planned Behaviour suggests that attitudes, social norms and perceptions of control combine to create an intention; a precursor state to an action. Without favourable attitudes, social norms and perceptions of control, an intention is not created and action does not occur. This social-psycho theory is useful for explaining why change does not occur when attitudes are positive. It is also possible for attitudes, social norms or perceptions of control to be mixed and the other constructs to be positive or negative when creating a positive intention to change. In this study we saw two groups of farmers express mixed attitudes towards technological change, but the Reluctant Group also expressed pessimistic perceptions of their social norm and their ability to change by referencing the amount of bureaucratic barriers in their way to change. The Optimistic Group of farmers also expressed mixed attitudes towards technology but expressed positive perceptions of their social norm and their ability to adopt new technology. The Optimistic Group also demonstrated an ability to apply how this as yet undeveloped application would be used on their farm. This suggests that those working in farmer education and the provision and design of farm extension services should focus on the ease of technology adoption and the fact that their peers are using it as well to encourage greater adoption of new technologies.

References

Clark, C. C. A. *et al.* (2016) 'Farm membership of voluntary welfare schemes results in better compliance with animal welfare legislation in Great Britain', *Animal Welfare*, 25(4), pp. 461–469. doi: 10.7120/09627286.25.4.461.

European Court of Auditors (2016) *Making cross-compliance more effective and achieving simplification remains challenging*. doi: 10.2865/49455.

Gambelli, D. *et al.* (2014) 'Non-compliance in organic farming: A cross-country comparison of Italy and Germany', *Food Policy*. Elsevier Ltd, 49(P2), pp. 449–458. doi: 10.1016/j.foodpol.2014.05.012.

Kutter, T. *et al.* (2011) 'The role of communication and co-operation in the adoption of precision farming', *Precision Agriculture*, 12(1), pp. 2–17. doi: 10.1007/s11119-009-9150-0.

Long, T. B., Blok, V. and Coninx, I. (2016) 'Barriers to the adoption and diffusion of technological innovations for climate-smart agriculture in Europe: Evidence from the Netherlands, France, Switzerland and Italy', *Journal of Cleaner Production*. Elsevier Ltd, 112, pp. 9–21. doi: 10.1016/j.jclepro.2015.06.044.

Pluto-Kossakowska, J. *et al.* (2013) 'Use of remote sensing in control of good agricultural and environmental conditions on agricultural farms', *Ecological Questions*, 17(January), pp. 75–87. doi: 10.2478/ecoq-2013-0018.

R Development Core Team (2013) 'R: A Language and Environment for Statistical Computing'. Vienna, Austria.

Reichardt, M. and Jürgens, C. (2009) 'Adoption and future perspective of precision farming in Germany: Results of several surveys among different agricultural target groups', *Precision Agriculture*, 10(1), pp. 73–94. doi: 10.1007/s11119-008-9101-1.

Tiffin, R. and Balcombe, K. (2011) 'The determinants of technology adoption by UK farmers using Bayesian model averaging: The cases of organic production and computer usage', *Australian Journal of Agricultural and Resource Economics*, 55(4), pp. 579–598. doi: 10.1111/j.1467-8489.2011.00549.x.