Smartphone farming in Ireland

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Abstract

This paper provides a baseline assessment of Irish farmer engagement with digital technologies in operating their farm businesses pre-COVID using nationally representative data from the 2019 Teagasc National Farm Survey. The analysis thus identifies those farmers most equipped to adapt to the changing communication and operational environment and those most vulnerable to exclusion and isolation. Survey results confirm that dairy farmers are more engaged with computer and smartphone technology in operating their farm business. Preliminary econometric investigations confirm the importance of socio-demographic factors relating to both farm and household in influencing farmer uptake of such technology. More engaged farmers tended to be younger, living in younger households and with higher agri-educational qualifications. Conversely, older farmers living alone, were less likely to use ICT in conducting their farm business. Further in-depth econometric investigation is required to explore the drivers and barriers to technology adoption.

1. Introduction

Communication channels have changed rapidly since the onset of the COVID-19 pandemic across all sectors, not least amongst agricultural stakeholders. Indeed a shift to e.g. online livestock marts and virtual advisory events look set to continue. To this end, this working paper investigates how well equipped Irish farmers are for this changed operating environment by exploring their engagement with both computers and smartphones in the operation of their farm business. There has been limited research on smartphone use by farmers in particular, although a number of recent papers have been insightful (Kongaut and Bohlin 2016, Michels 2020).

To support agricultural development in general, and more effective farm management specifically, technology adoption is seen as crucial (McFadden and Gorman 2016). In this context, digitalisation as well as information and communication technologies (ICT) innovations may lead to direct production gains or cost reductions in agriculture and can improve farmers' access to and use of data and information for farm management purposes.

According to Michels et al. (2020) smartphone technology is promising for the future development of agriculture, as it can facilitate and improve many operational procedures. Indeed, the potential combination of smartphone and precision agriculture technologies (PAT) through their integration with on-farm sensors to facilitate and mediate data collection is increasingly recognised (Michels et al., 2020). This capacity may also be of real use in terms of collecting and collating relevant data for evolving CAP monitoring and evaluation needs through the Performance Monitoring and Evaluation Framework (PMEF). As such, farmer uptake of smartphone and computer technology will be crucial to further facilitate the acceptance and uptake of such technologies.

In an Irish context, this working paper builds on previous research by Hennessy et al. (2016) involving an investigation of farm household computer use in 2011. The paper described the transformational change with regard to Irish farm household engagement with ICT over time, with 63% of households reporting access to a computer in 2011 compared to 40% in 2004. Despite this, only 33% were using a computer in the operation of their farm business. It is envisaged that this has increased strongly in the interim, with data from the Teagasc National Farm Survey (NFS) illustrating that 34% of farmers were using smartphones for farm business purposes in 2015.

Recent developments in smartphone technology, access to mobile internet, and cloud services have led to an increase in the number of smartphone apps supporting farmers' decision-making (Rose et al., 2016). As smartphone use has been steadily increasing, there is a recognition of the need to gauge farmer engagement with same, in particular in relation to the operation of their farm business. This is assessed here using nationally representative data collected through the 2019 Teagasc NFS additional survey mechanism. The analysis thus identifies those farmers most equipped to adapt to the changing communication and operational environment (quickened by the COVID-19 pandemic) and those most vulnerable to exclusion and isolation.

Previous research has identified important socio-demographic and farm household characteristics influencing the adoption of particular technologies such as ICT. Tey and Brindal (2012) reported relevant influencing factors as relating to: socio economic, agro-ecological, institutional, informational, perception, behavioural and technological. Hennessy et al. (2016) found that younger dairy farmers were more likely to engage with such technology, whilst older farmers living alone were at an isolation risk. Michels (2020) also indicated that farmers' age, education, and farm size were determinants of smartphone adoption.

Irish dairy production has increased dramatically in preparation for and as a result of EU milk quota abolition in 2015, with the volume of milk produced over the period 2008 to 2021 increasing by over 75% (CSO, various years). As dairy herd sizes increase, herd management becomes increasingly difficult and time consuming for a dairy farmer (Gargiulo et al., 2018). Insufficient herd management can result in reduced animal welfare and health, which can lower cow performance and harm the economic status of the dairy farmer (Calsamiglia et al., 2018). Furthermore, record keeping and evaluation at the cow level are considered to be essential for monitoring herd performance and making effective herd management adjustments if necessary (Barragan et al., 2016).

According to Bonke et al., (2018), smartphones are very well suited to farmers' daily working routine due to their mobility, built-in sensors, constant access to updated information via mobile internet and multifunctionality via agricultural apps. Michels and Mushoff (2021) contend that smartphone technology can contribute to a more environmentally friendly and animal-welfare orientated agricultural production by providing access to the necessary knowledge, data and stakeholders for each individual farmer.

In an Irish context, technology has the potential to assist the mainly family farms to manage workload during this expansionary phase. Therefore, an exploration of the drivers and barriers to the adoption of computer and smartphone technology is of particular relevance. Understanding the timing of adoption is crucial to anticipate and foster the process of diffusion by identifying the early adopters and those who delay the adoption decision. Identifying late adopters could help policy makers and agricultural extension services to develop programs that tackle barriers faced in the adoption of smartphones, agricultural apps and complementary technologies. Ultimately, this knowledge can then be used to foster the diffusion of smartphones and other technology among farmers (Michels et al., 2020).

2. Data

The data utilised in this analysis was collected through the Irish Teagasc National Farm Survey in 2019. The Tegasc NFS operates as part of the EU Farm Accountancy Data Network (FADN) data, which are. The survey collects data on an annual basis from a statistically representative random sample of approximately 900 farms, representing a farming population of approximately 90,000 farms. Farms are classified into farming systems based on the dominant enterprise that is calculated on a standard gross margin basis. The NFS distinguishes between farm systems: dairy, cattle rearing; cattle other; sheep and tillage. Data was collected through a wide ranging additional survey *(N=709)* in which farm household computer, internet and smartphone usage was explored and an insight into the purposes of such gained, with a particular emphasis on their conducting of farm business e.g. farm accounts, herd management and farm input and output purchases and sales.

Informed by the literature, a range of descriptive statistics are included in Table 1 below. These are reflective of potentially important farm and farmer characteristics. The difference between dairy farms and all farms is highlighted as previous analysis of NFS data in 2016 by Hennessy et al. found that dairy farmers were more likely to use computers for farm business purposes. Furthermore, Irish dairy farms consistently report higher average family farm income, tend to be more specialised and more intensive than average drystock (cattle and sheep) operations. Tillage (crop) farms are deemed to be less relevant in this analysis given the relatively higher proportion of outsourced (contractor) work carried out on those farms. That said, a more in-depth investigation of precision technologies (e.g. GIS, GPS) on those farms is merited at a future stage. In terms of farm system representation within the sample, 39% of the farms were dairy 39% cattle, 14% sheep and 8% tillage.

Table 1: Descriptive statistics – Teagasc Additional National Farm Survey 2019

	All Farms (N = 709)	Dairy Farms (N = 277)
UAA size (hectares)	62.2 (*47.8)*	72.5 *(38.9)*
Farm Income per ha (€)	651.4 *(566)*	1,122.4 (*596)*
Investment per ha (€)	309.6 *(674)*	498.3 *(1,004.5)*
Farmer Age (years)	57.0 *(12.4)*	52.6 (*13.5)*
Advisory Contact (%)	.69 *(.46)*	.79 *(.40)*
Off-Farm Job (Holder)	.24 *(.43)*	.09 *(.28)*
No. of Household Members	2.9 *(1.5)*	3.3 *(1.5)*
Farmer Lives Alone	.16 *(.37)*	.08 *(.27)*
Farmer Training (%)	.65 *(.48)*	.82 *(.39)*
Off-Farm Job (Spouse)	.49 *(.54)*	.43 *(.55)*

*Means with Standard Deviations in parentheses

3. Survey results

Previous literature has discussed the issue of the digital divide in terms of inadequate access to internet in some rural areas (Skerrat, 2012, Hennessy, 2016). Data from the 2019 NFS additional survey indicated that 80% of respondents had access to the internet, with the remaining 20% not having access. In terms of the latter, this did not appear to be a matter of access, as the main reasons given were not needing/wanting internet, with some citing a lack of knowledge. As regards access to quality broadband, 13% of respondents reported the broadband quality as being very good, with a further 36% stating that it was good. Broadband quality was reported as being average for 33%, with 13% and 5% stating that it was poor or very poor respectively.

The survey investigated both household access and farmer utilisation of ICT, an overview of which is contained in Table 2. 79% of all farms, reported access to a household computer, the proportion largest on dairy and tillage farms at 95% and 90% respectively. The proportion of farmers with a mobile phone was very high, at 92%, varying marginally across systems. The proportion using smartphones was markedly lower, at 60% on average, and highest on dairy farms, reflective of their generally lower age category, on average.

In line with previous literature, a lower proportion of farmers reported using ICT for farm business. According to this data, dairy farmers tended to utilise computers and smartphones for farm related business to a much greater extent than other farmer types. 78% of dairy farmers reported using a computer for farm business, compared to 57% for cattle farmers and 53% for sheep farmers. The proportion using a smartphone for farm related business was lower again, at 68% for dairy farmers compared to 54% on average across all farms.

Table 2: ICT use across Irish farm systems 2019

%	Dairy	Cattle	Sheep	Tillage	All farms
Household Computer	95	74	76	90	79
Farmer Mobile phone	92	93	87	99	92
Farmer Smartphone	74	58	50	67	60
Computer – Farm Business	78	57	53	72	62
Smartphone – Farm Business	68	49	56	57	54

**Note: Dairy farms 39% of sample, Cattle 39%, Sheep 14% and Tillage 8%.*

Information on farmer computer use for non-farm purposes was also garnered from the survey. This would also be indicative of farmer engagement with technology generally, and readiness to adopt new technologies in the context of their farm. Across all categories listed in Table 3 below, the proportion of dairy farmers utilising computers for personal use was higher than on other farms, for all use categories.

Table 3: Farmer computer use - personal

%	All Farms (N = 709)	Dairy Farms (N = 277)
Email	41	44
Social Media	17	25
Video calls	9	24
Newspaper access	15	38
Streaming	13	14
Motor Tax	30	41

Table 4 reports farm business related activities undertaken by farmers, for all farms, and dairy farms specifically. Farmer engagement across some categories was broadly similar e.g. farm accounts, accessing farm news, administrative paperwork and chat groups e.g. WhatsApp. For other purposes, dairy farmers reported higher levels of utilisation e.g. technical advice, herd

management, buying inputs and selling produce. Further investigation of this data and drivers and barriers to same is planned in the next phase of this research.

Table 4: Farmer computer use – farm business

%	All Farms (N = 709)	Dairy Farms (N = 277)
Farm accounts	60	64
Herd register	73	80
Tech advice	56	62
Herd management	53	62
Buying inputs	63	71
Selling produce	65	74
Administration	69	71
Price comparison	49	54
Farm news	51	49
Chat group	53	54
Compliance information	58	65
Banking	77	81
Production planning	51	58

4. Econometric Methodology

This working paper aims to empirically explore the factors influencing ICT use for farm business purposes by Irish farmers. Specifically, this relates to computer and smartphone adoption, across a range of farm management purposes. An initial econometric investigation has taken place, although it is proposed to further explore the methodology and conduct more detailed analysis.

Adoption decisions can be modelled as binary choices (1=Yes; 0=No) using a binomial logit model. This is the approach taken here. The relationship between farmers, farm characteristics and both computer/smartphone adoption in the operation of the farm was analysed using this framework, following the approach of Michels (2020), in their analysis of German farmers' smartphone adoption. Numerous previous agricultural studies have taken this approach with regard to adoption of precision agriculture (e.g. Tey and Brindal 2012).

Given dairy farmer engagement with ICT for farm purposes, the model discussed here is inclusive of dairy farms only (N=277) and is estimated to determine important farmer, household and farm characteristics that influence or hinder farmers' engagement with technology (including smartphones) in operating their farm business.

5. Model Results

In line with the literature, preliminary econometric results (in Table 5) highlight the importance of socio-demographic factors in influencing dairy farmer uptake of ICT in running their farm businesses. The effect of all variables is significant. Marginal effects are also calculated, to illustrate the percentage probability of farmer uptake of the technology due to the variable in question.

The model indicates that more engaged dairy farmers tend to be younger, living in younger households and with higher agri-educational qualifications. Conversely, those farmers living alone, with lower educational qualifications appear less likely to use computers or smartphones in the operation of their farm business.

Table 5: Binary Logistic Model of Farmer Use of Computer and Smartphone Technology in the Operation of their Farm Business – Irish Dairy Farmers (2019)

	Coef.	**P>z**	**Marginal Effect**
Farmer age >50	-0.212	0.000	-0.05
Household members <20	0.351	0.000	0.08
Formal Agric. Qualification	0.992	0.000	0.21
Farmer lives alone	-1.252	0.000	-0.27
Mid West region	1.668	0.000	0.36
Hired labour on farm	0.166	0.000	0.04
Land rented in	0.321	0.000	0.07
Farm Family Income	0.000	0.000	0.00
Contracting expenditure	0.000	0.000	0.00
Farm accountant	0.000	0.000	0.00
Farm investment	0.000	0.000	0.00
Second level education	-0.290	0.000	-0.06
Spouse off-farm job	-0.160	0.000	-0.03
Milk Recording	0.166	0.000	0.04
_cons	-0.561	0.000	
N = 277			
Pseudo R2 = .101			

The location of the farm is also important, with farms located in the mid-west region more likely to engage with the technology. Those utilising hired labour on the farm and renting in land are also more likely to engage with ICT according to the model.

Although positive and significant, the marginal effect of farm family income, expenditure on farm contracting, accountant fees and investment on farmer engagement with ICT is very small.

Interestingly, those farmers whose spouse works off the farm are less likely to engage with the technology. Conversely, those already utilising milk recording technology are more likely to engage. As technology adoption is generally more likely on farms where other technology is embraced, this is an interesting finding.

However, further econometric investigation is required here, particularly as the model fit is not very good (pseudo R^2 =10.1). Further exploration of the data and the most suitable econometric modelling techniques will be conducted during the next phase of this research.

6. Discussion and Conclusion

This paper provides a baseline assessment of dairy farmer engagement with digital technologies in operating their farm businesses pre-COVID. The evolution in farmer behaviour in this regard is charted through time and an evaluation of how well equipped Irish farmers are to adapt to a changed operating environment made.

Recent literature is reflective of the cultural and social context in farmer use and non-use of technology (Pavez et al., 2017). Preliminary results here are in line with previous research (Gloy, 2000 and Michels, 2020) indicating that, among other factors, farmers' age and education are determinants of ICT adoption. The age profile of the household is also important as found by Hennessy et al. 2016.

Previous research has indicated that ICT use on farms is linked to productivity and efficiency gains, with internet use positively linked to farm performance and income. Farmer engagement with digital technologies will be critical to the future sustainability of agriculture and the increased need for farm-level data for policy monitoring and evaluation purposes. This paper identifies key farmer, household and farm characteristics to inform how best to engage with farmers in this regard.

Farmer engagement is associated with the adoption of a wide range of ancillary technologies. Farmer uptake of smartphone and computer technology will be crucial to further facilitate acceptance and uptake of precision agriculture technologies etc. There is a role for extension

in improving farmer uptake. A recent paper by Schulz et al. (2022) reported the influence of farm advisors and farmer network participation in the adoption of farm related smartphone apps (computer applications for mobile devices) by farmers. They conclude that such apps have the potential to revolutionise the way farmers undertake training, extension, and support more informed decision making. As this survey contains information of farmer use of apps and has valuable data on farmer networks (through dairy discussion groups), an investigation of the data is planned during the next phase of this research.

The COVID-19 pandemic brought much challenge but has provided an opportunity for an expanded suite of farm communication and management tools. Data collected through the 2021 Teagasc NFS will also provide valuable information on how farmers have adapted to the new operating environment with regard to online livestock sales and farm extension etc.

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