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Going beyond FADN: The use of additional data to gain insights into extension service use across European Union Member States

This paper examines the use of extension services by farm households across eight European Union (EU) Member States, exploring the type of extension service engaged with, the degree of engagement and the type of information sought. The impact of extension on economic, environmental and social sustainability is also considered. European data utilised are those collected from a pilot sample of 820 households in 2015/2016 as part of the EU Framework 7 project FLINT, from which the Irish results are incorporated further with Irish Farm Accountancy Data Network data. The results outline the key contrasts across the countries investigated and suggest that the degree to which households engage with extension services is primarily influenced by national policies. In addition, this analysis indicates that the extent of this engagement has implications for sustainability at the farm level. The final conclusions and policy recommendations in this paper support the development of a large-scale version of the FLINT pilot survey.

Keywords: agricultural sustainability, extension use by farmers

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Introduction

The global demand for food is increasing rapidly, resulting in agricultural expansion and a growth in associated environmental degradation. It has been projected that by 2050 the demand for crops will be 100-110 per cent higher than 2005 levels. If current trends in agricultural production in developed and developing nations continue, then one billion hectares of land will be cleared globally by 2050, resulting in vast increases in CO_2 emissions and nitrogen use (Tilman *et al*., 2011). As the global population edges towards 9 billion, the required increase in food production must become more sustainable, socially, environmentally and economically. The provision of knowledge, research and innovative technologies through farm advisory systems will play a vital role in this sustainable development (EU SCAR, 2012).

In Ireland, two key policies which focus primarily on increased food production have been introduced: Food Harvest 2020 and Food Wise 2025. The first of these policies, published in 2010, aims to increase the value of the primary output of the agriculture, fisheries and forestry sector by 33 per cent over the 2007-2009 average; to improve the value added in the sector by EUR 3 billion; to achieve an export target of EUR 12 billion; to increase milk production by 50 per cent; to add 20 per cent to the value of the beef sector and to double the industry spend on research and development by 2020 (DAFM, 2010). Food Wise 2025 expands on this, with the core aims of increasing the value of agri-food exports by 85 per cent; increasing value added in the agri-food, fisheries and forestry sector by 70 per cent; increasing the value of primary production by 65 per cent and creating 23,000 direct jobs in the agri-food sector by 2025 (DAFM, 2015). An environmental analysis of Food Harvest 2020 concluded that, in a scenario without best practice knowledge and innovation, the policy could lead to negative impacts on biodiversity, flora and fauna, water quality, air quality and climatic factors. This report indicated that the introduction of best practice technology from farm advisors through increased knowledge and skills could mitigate these negative impacts and enhance environmental outcomes (Farrelly *et al*., 2014).

The European Union (EU) has introduced measures designed to achieve continued food security while also maintaining environmental and social sustainability standards. Under the 2003 Common Agricultural Policy (CAP), EU Member States were obliged to introduce a formal system to advise farmers on land and farm management, known as the Farm Advisory System (FAS). The primary goal of the FAS was to assist farmers in becoming aware of issues relating to the environment, food safety, animal health and welfare, and to fulfil EU requirements and avoid any associated financial penalties. Farmer participation in this scheme was voluntary. While the FAS did improve farmers' awareness of issues related to the environment, food safety and animal welfare, the effectiveness of the programme was limited as few farmers actively sought advice (EC, 2010).

From a policy perspective, the contribution of extension services to the general sustainability of farms will become increasingly important as the policy goal of sustainable agriculture rises in importance. The sustainability of agriculture can be measured through the use of farm-level sustainability indicators (Dillon *et al*., 2016). The role of extension in the sustainable intensification of agriculture which will be addressed in this paper has not been heretofore been examined in detail although Nordin and Höjgård (2016) outline the positive impact of extension contact on land use management and fertiliser use efficiency in Sweden. Furthermore, it is widely accepted that an improved understanding and uptake of technologies as well as advances in areas such as agroecology, biogeochemistry and biotechnology are crucial for the continued sustainability of agriculture (Tilman *et al*., 2002) and extension contact is the most logical mechanism for the transfer of such knowledge to farmers. In an Irish context, several studies have investigated the

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economic impact of extension service interaction (Hennessy and Heanue, 2012; Bogue, 2014; Heanue and O'Donoghue, 2014; Cawley *et al*., 2015).

This research differs from those cited as the environmental and social impacts of extension use are also explored. In addition, a more in-depth examination of the type of extension services utilised, the specific information requested and the frequency of engagement are taken into account. This work investigates pilot data from eight EU Member States participating in the EU Framework 7 project FLINT (Farm-Level Indicators on New Topics in policy evaluation), and incorporates the Irish results with data from the Teagasc National Farm Survey (NFS) Irish Farm Accountancy Data Network (FADN) data. The FLINT data include information on issues not otherwise available from FADN surveys such as information and knowledge, working conditions and quality of life, innovation, land management and pesticide usage. This analysis examines the value of these additional data on extension service participation and analyses the impact of the intensity of extension service use on sustainability outcomes.

Agricultural extension services and output

Agricultural extension services are a mechanism by which policy-relevant research can be transferred to the farm level. They comprise public and private sector activities relating to technology transfer, education, attitude change, human resource development, and the dissemination and collection of information (Marsh and Pannell, 2000). Such services can assist farmers by assessing their socio-economic situation and informing them of their potential and barriers to development. This can be conducted through direct or indirect interaction with the farmer by way of an agent or intermediary organisation and with the use of education services and information provision via mass media.

In Ireland, Teagasc (The Agriculture and Food Development Authority), a state body, acts as the primary provider of advisory services to farmers, delivering research, advice and training. Private sector planners also provide extension services. Since the mid-1990s, Teagasc has moved towards a model of participatory extension which sees farmers as full collaborators in research and extension (Mahon *et al*., 2010). One such form of extension is that of discussion groups, which consist of a group of local farmers who meet regularly on farms to see, discuss and learn about technologies and practices that may be applied on their own farms. These discussion groups are becoming increasingly popular in Ireland and are used widely to transfer knowledge (Hennessy and Heanue, 2012).

In line with international research, extension services in Ireland have been found to have positive impacts on financial outcomes for farmers. Heanue and O'Donoghue (2014) conducted a descriptive and econometric analysis of results from the Teagasc NFS during the period 2000-2011. They found that family farm income was highest for those households where the farmer had obtained an agricultural certificate or had gone to agricultural college. Both the private returns (costs and benefits to the farmer) and social returns (impact on the state of output and other income streams relative to the cost of providing the education) to investment of agricultural education were positive. Agricultural education improved a farmer's technical and allocative efficiency in three ways. Firstly, education assisted farmers in making better use of information and in finding solutions to issues which made them more efficient in allocating their resources. Secondly, education meant that farmers had improved access to the information they required. Thirdly, due to this improved information, educated farmers were more likely to be early adopters of new technology or products.

Hennessy and Heanue (2012) assessed the effectiveness of dairy farm discussion groups (a form of participatory extension) in Ireland using discrete choice models. Discussion group membership was associated with increased use of technology and higher farm profits. It is suggested that the learning atmosphere associated with discussion groups, i.e. a positive, familiar, trusting environment, can facilitate greater social and interactive learning. Similarly, Bogue (2014) highlights the positive benefits to farmers which resulted from participation in beef discussion groups run by Teagasc. On average, discussion group members had higher output and an overall higher average gross margin per hectare than non-members. Sixty-one per cent of discussion group members made improvements to their overall profit and half of the participants experienced a financial benefit from taking part in the group.

Cawley *et al*. (2015) utilised an instrumental variable approach to establish the impact of the decision to participate in extension programmes on farm-level outcomes. They established that omitted variable and self-selection bias may be present within the sample, i.e. that farmers' ability or motivation would have an impact on the decision to engage and that higher-skilled farmers may choose to take part due to their capacity and willingness to improve their business. On the contrary, these high achievers may be less likely to engage given their propensity to succeed without assistance. Therefore, the decision to engage may be endogenous and so instrumental variables must be used. Using the distance to the local advisory service and the introduction of the Single Farm Payment Scheme in 2005 as instruments, on the assumption that distance and the complex new scheme may influence a farmer's decision to take part in a way that is unrelated to performance, this study found a positive net benefit to extension engagement.

Although these studies show that extension services can contribute to economic sustainability, there is a gap in the literature with respect to the potential impact of engagement with extension services on social and environmental sustainability. Similarly, little has been written about the effect that frequency of farmer engagement with extension services may have on these outcomes. In the following sections we explore whether the use of the additional data provided by the FLINT study can shed light on these issues. We hypothesise that engagement with extension services will have a positive influence on sustainability indicators; the degree of engagement and type of advisory services used will differ among the EU Member States due to national policy differences and that more intensive engagement with extension services will result in more sustainable farm outcomes.

Methodology

Sustainability indicators

The concept of sustainable development was first introduced in the late 1980s by the 'Brundtland report' (WCED, 1987). It is defined from an economic point of view as preserving or enlarging capital stock in the form of economic, social and natural capital (Pingault, 2007). Concerns regarding both the sustainability of agriculture itself and its contribution to sustainable development are becoming increasingly important to policymakers (Bockstaller *et al*., 2009). Sustainability of agriculture is measured as a function of three parts: economic (the production of goods and services), environmental (the management of natural resources) and social (the contribution to rural dynamics) (Diazabakana *et al*., 2014). These three categories are known as the sustainability pillars.

Measuring sustainability allows for comparisons, in this case between farmers who use extension services and those who do not. To do this, indicators, defined by OECD (2001) as 'a representative measure involving raw data on a phenomenon that is important for policy makers', are selected under each of the pillars. Indicators for this study (Table 1) were chosen with consideration for both the available data and the topic of extension services under consideration and are based on those designed by Hennessy *et al*. (2012). These measures provide a 'snapshot' of the farm's current productivity. It is possible that high gross output per ha this year could lead to soil degradation in subsequent years. Therefore, although the farm appears sustainable this year, it may not be in the longer term. As the analysis in this paper focuses primarily on one year's worth of data, long-term analysis is not conducted.

Table 1: Sustainability indicators used in this study and their method of calculation.

Indicator	Measure	Unit
Economic		
Productivity of land	Gross output per ha	EUR per ha
Profitability	Market-based gross margin per ha	EUR per ha
Productivity of labour	Family farm income per unpaid labour unit	EUR per labour unit
Viability of investment	Farm is economically viable*	1= viable, 0= not viable
Market orientation	Output derived from market	Per cent
Environmental		
Greenhouse gas (GHG) emissions	Emissions per ha using IPCC estimates**	kg CO_2 equivalent per ha
Risk to water quality	Nitrogen per ha	kg N surplus per ha
Social		
Household vulnerability	Farm is not viable and no off farm employment	1= vulnerable, 0=not vulnerable
Education	Agricultural education attainment	1= educated, 0=not educated
Isolation risk	Live alone	1=yes, 0= no
Work-life balance	No. hours worked	No. hours worked on the farm

* Farm is viable if the farm can pay for family farm labour at the minimum agricultural wage plus a 5 per cent return on non-land assets.
** The methodology utilises a combination of Tier 1 and Tier 2 approaches to estimate GHG emissions per farm (tonnes of carbon dioxide equivalent, tCO_2eq) by applying relevant Intergovernmental Panel on Climate Change (IPCC) coefficients to animal numbers (on the basis of age category). IPCC Tier 1 utilises simple methods with default values. Tier 2 methods include country-specific emission factors. Tier 3 includes more complex approaches, possibly models.
Source: own compilation

In order to assess if there are statistically significant differences between those who engage with extension services and those who do not, the differences in the means of extension services users and non-users for each of the sustainability indicators are tested using either a t-test or chi square test using Irish FADN data. Eleven OLS regressions were conducted, one for each indicator. These indicators will be the dependant variable. Each regression includes the same independent variables, outlined in the following section, which include information on farm system, soil type etc. The independent variable of interest is 'extension'; a dummy variable taking a value of 1 if the respondent engages with extension services.

Using the new information provided by the FLINT data, respondents are classified as 'low' or 'high' extension service engagers. With this information, the difference in means of those who engage with extension services less frequently and more frequently is tested using either a t-test or chi square test. Following this, two sets of OLS regressions are conducted using the selected sustainability indicators. The first set of regressions using the sustainability indicators as the dependent variable selects a dummy variable representing 'low' extension participants as the independent variable of interest. The second set selects a dummy variable representing 'high' extension participants as the independent variable of interest.

FADN Data

Irish FADN data for 2015, collected through the Teagasc NFS, which surveys a statistically-representative random sample of farms, are used for this analysis. Face-to-face interviews were conducted by a professional data collection team. The NFS also provides more detailed information used to supplement the FADN in this study. This analysis looks at all the farm systems on which data are collected, namely dairy, cattle rearing, cattle other, sheep, tillage and other. These are classified on a standard gross margin basis. The FADN data are used to examine the impact of extension participation on each indicator listed in Table 1. Other variables included in this analysis are a range of farm characteristics including the farm system (detailed above) and soil type. This variable is comprised of three classifications: class 1 indicating soil with little or minor limitations in terms of agricultural use; class 2 comprising of soils with more limitations, poorer drainage and those that are generally unsuitable for tillage; and class 3, consisting of soils that are greatly limited in terms of agricultural use, primarily found in the West of Ireland and mountainous areas. Variables are also included to classify those areas designated as 'less favoured'[6]. Three dummy variables are included: the first consisting of those regions not classed as disadvantaged; the second comprising of less severely disadvantaged areas and the third, indicating regions regarded as severely disadvantaged. The number of people in the household is also included. Region variables

[6] In accordance with Council Directive 75/268/EEC of 28 April 1975 on mountain and hill farming and farming in certain less-favoured areas.

are also included; however the Dublin region is excluded from the analysis due to the small sample size.

Results

Summary statistics using Irish FADN data

The differences in means of extension services users and non-users for each of the sustainability indicators used in this study are presented in Table 2. The significance of these differences is tested using either a t-test or chi square test. This preliminary analysis indicates that there are significant differences between the two groups for all but one of the indicators, isolation risk. Extension users have a higher output per hectare on average by more than EUR 600 compared to their non-extension user counterparts. Extension users are also doing better on average for all of the other economic indicators. The environmental indicators show the opposite with extension users faring worse in both the GHG per hectare measure and nitrogen surplus per hectare. This is consistent with the results of Lynch *et al*. (2015).

Socially, extension users scored better on both household vulnerability and education, but worked over 200 hours more than non-extension users.

These calculations do not take into account the presence of self-selection bias. Farmers who already run their farms more efficiently than their counterparts often are those who choose to participate in extension programmes (Dercon *et al*., 2009). On the other hand, it may be the poorer performing farmers, in greater need of advice, who seek out the extension programmes. This would result in the over or under estimation of the effect of extension services, especially in relation to economic variables.

As only one year of data (2015) was available for this analysis, more elaborative analysis, such as instrumental variable regressions or endogenous switching regression analysis, could not be conducted due to a lack of suitable instruments. However, these data are used subsequently in our OLS analysis described below, which provides a basic outline of the importance of extension participation and the level of engagement in extension programmes for economic, environmental and social indicators.

FLINT data

The Irish FADN data provide a range of information on economic, environmental and social outcomes, but they are limited in terms of detail on the degree of farmer engagement with extension services. More detail is provided by the FLINT data, including types of advisory services used, information obtained and the mean number of engagements per farmer. The FLINT data are subsequently incorporated with the FADN data in OLS regressions, as described below. Following the methodology used above, the sustainability indicators are the dependent variables of interest. The FLINT data can then provide two important independent variables: a binary variable indicating whether or not the farmer is a low extension user and a binary variable indicating whether or not he or she is a high extension user. As above, the FADN and NFS data provide the other explanatory variables such as farm system, soil type etc. The full FLINT sample in this paper includes data from 820 farms for eight EU Member States, namely Finland (50), Germany (52), Greece (124), Hungary (102), Ireland (64), the Netherlands (155), Poland (145) and Spain (128). Although not nationally or geographically representative, it provides useful pilot information on the type of information and extension services availed of by the sample respondents.

Extension service use

The FLINT data provide greater detail of the type of extension service being used and the frequency of engagement with these service providers. Such information is useful as the intensity of participation or level of interaction with extension services is an important factor in increasing net farm income (Akobundu *et al*., 2004). The mean numbers of engagements with each advisory service in 2015 for the countries in the FLINT sample (Figure 1) reflect the number of times a farm obtained information from the relevant advisory services on a range of topics. Each instance of a specific information request is regarded as an additional engagement regardless of whether or not the farmer has used the same service on the same day e.g. requesting accountancy information and crop information from a public advisory service in one day is calculated as two engagements.

Table 2: Difference in means for sustainability indicators for non-extension and extension users.

	Non-extension		Extension		Difference	
	mean	s.d.	mean	s.d.	value	t
Output per ha	1567.26	1053.87	2208.98	1255.15	-641.73	-7.90***
Gross margin per ha	684.37	612.60	1058.29	745.94	-373.92	-7.84***
Family farm income per labour unit	23166.60	22851.69	38584.11	36652.14	-15417.52	-7.60***
Viability	0.39	0.49	0.58	0.49	-0.20	29.19***(χ^2)
Market orientation	0.70	0.15	0.77	0.14	-0.07	-6.60***
GHG per ha	4.44	2.59	5.62	3.06	-1.18	-5.91***
Nitrogen per ha	65.79	60.44	96.39	74.92	-30.60	-6.46***
Household vulnerability	0.44	0.50	0.31	0.46	0.13	13.26***(χ^2)
Education	0.47	0.50	0.65	0.48	-0.18	26.66***(χ^2)
Isolation	0.16	0.36	0.13	0.34	0.02	0.32(χ^2)
Hours worked	1854.72	710.36	2088.29	710.81	-233.56	-4.53***
N	280		597		877	

*** $p<0.01$, ** $p<0.05$, * $p<0.1$
Source: own calculations

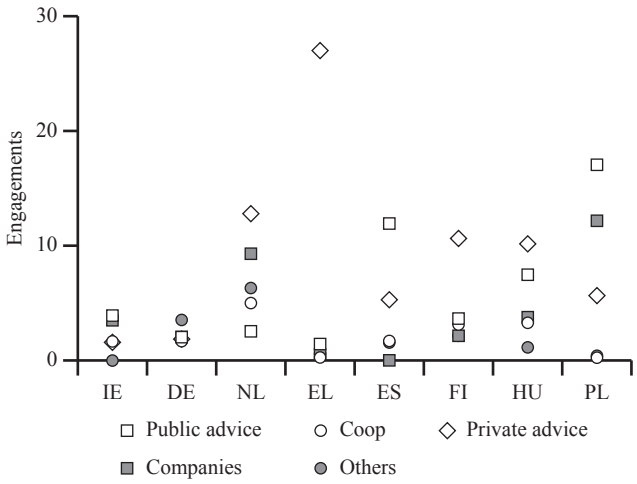

Figure 1: Mean number of engagements per farm with each advisory service in 2015 per EU Member State: full FLINT sample.
Source: own data

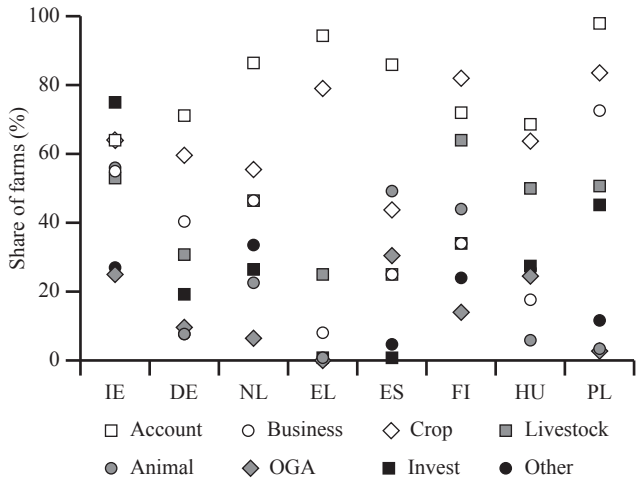

Figure 2: Percentage of respondents requesting information in 2015 by information type per EU Member State: full European sample.
Source: own data

'Public advice' refers to all public advisory services or public extension agents offering direct advice services to the farmers e.g. advisory centres, chambers of agriculture, agricultural authorities, state-owned advisory firms and public research institutes. Poland has the highest number of engagements with this advisory type for the FLINT sample, with a mean of 17 in 2015. The lowest for this category is found in Greece, with a mean of just 1.4. The next service type includes farmers' cooperatives or organisations which offer direct advisory services to the farm. This service type is most popular in the Netherlands, with a mean engagement of 5, and least popular in Poland with a mean of 0.25. 'Private advisors' include all independent private consultants or consultancy firms e.g. accountancy firms, veterinary experts and private advisory companies. Greece presents an interesting result for this service type, with a mean engagement of 27 per farm in 2015. One farm in Greece interacted with private advisors 315 times in 2015, and four farms engaged with private advisors over 100 times in total. Excluding these four farms brings the mean number of engagements to 22, which still remains the highest mean for all service types. 'Companies' includes all firms downstream and upstream along the value chain whose principal business is not the provision of advisory services. These include input traders, processors and wholesalers (for example: input shops, bank officers, buyers). Poland avails of this service the most, with a mean engagement of 12, and Spain the least, with just two farms in the Spanish sample using this type of service.

The survey provided to respondents also included an 'others' and 'other farm-based providers' category, which incorporated all of the providers not covered in the previous categories; such as universities, environmental NGOs, private research institutes and religious organisations. This service type was used the most in the Netherlands, with approximately six engagements per farm, and the least in Ireland, with no farm using this type of service.

In Ireland, approximately 71 per cent of the 64 respondents availed of public advisory services; farmers' cooperatives were used by 58 per cent of the sample, private advisory services were consulted the least by respondents, with just 36 per cent of the sample using this service type. Companies were used by 77 per cent of the sample, the highest for all service types in Ireland. The mean number of engagements with all extension services for the Irish sample was ten. Four respondents did not engage with any extension services in 2015. Forty-four per cent of respondents in the Irish FLINT sample were classified as low extension users; i.e. they engaged with extension services between 0 and 8 times in 2015, and 22 per cent were classified as medium extension users, availing of extension services between 8 and 12 times in 2015. Finally, 34 per cent of the Irish FLINT sample respondents were categorised as high extension users, using extension services 13 times or more in 2015.

Information requested by farmers

The FLINT data also provide greater detail on the type of information requested by each farm in the sample (Figure 2). Approximately 98 per cent of the Polish sample asked for accountancy assistance. This includes advisory services for bookkeeping, accountancy, taxes and FADN. For all countries except Ireland and Finland, this category was the most sought after by the sampled farms. The Irish farmers were least interested in this type of information, with just 64 per cent of the sample seeking accountancy assistance. Advisory services for planning, monitoring or executing plans included business/financial/marketing planning, human resources, management, marketing advice and marketing information services. Again, Polish farmers were the most interested in this type of information with 73 per cent of the sample seeking help for these issues. The lowest proportion of respondents (just 8 per cent) requesting assistance on this topic came from Greece.

As regards advisory services which deal with issues related to crops production, Polish farmers were again the keenest to gain advice on this issue, as 83 per cent of the sample requested information. Spanish farmers sought this advice the least, as just 44 per cent of the sample requested this type of assistance. Finnish farmers requested assistance on issues related to livestock production the most (64 per cent) and Spain and Greece were joint lowest with just 25 per cent of each country's sample expressing an interest in

Table 3: Difference in means for sustainability indicators for low extension and other extension users: Irish FLINT sample.

	Non-extension		Extension		Difference	
	mean	s.d.	mean	s.d.	b	T
Output per ha	2132.02	1356.93	2703.08	1438.66	571.06	1.61*
Gross margin per ha	1059.94	853.12	1269.05	855.86	209.11	0.97
Family farm income per labour unit	37981.44	36290.34	35607.91	27510.59	-2373.53	-0.30
Viability	0.50	0.51	0.61	0.49	0.11	0.79 (χ^2)
Market orientation	0.77	0.14	0.81	0.12	0.03	1.21
GHG per ha	5.71	3.02	7.22	3.45	1.50	1.81**
Nitrogen per ha	97.75	72.68	144.47	93.66	46.71	2.2***
Household vulnerability	0.42	0.50	0.28	0.45	-0.15	1.59 (χ^2)
Education	0.46	0.51	0.69	0.47	0.23	2.48** (χ^2)
Isolation	0.14	0.36	0.14	0.35	0.00	0.00 (χ^2)
Hours worked	2019.00	643.19	2245.63	478.71	226.64	1.61*
N	22		42			

*** p<0.01, ** p<0.05, * p<0.1
Source: own calculations

livestock issues. For advisory services which aim to solve problems and implement solutions relating to animal products and services, this information was requested most in Ireland (56 per cent) and least in Greece with just one farm asking for this information.

Other gainful activities (OGA) covered advisory services which assist with issues related to other activities not comprised of farm work but which are directly related to the holding, e.g. tourist facilitation. This was sought most in Spain (30 per cent) and least in Greece, where no farms demanded this information. Investment included all advisory services related to a determined investment. This advice was requested most in Ireland, with 75 per cent of the sample seeking this information. Spanish and Greek sample farms were equally disinterested in this topic, as only one farm in each sample demanded investment assistance. The final category covered all other advice provided to the farm. While 34 per cent of farmers in the Netherlands sample sought this advice, no Greek farmers requested this information.

In Ireland, 75 per cent of respondents sought information about investment issues in 2015, the largest proportion of any FLINT country sample for this information type. The two national policies, Food Harvest 2020 and Food Wise 2025, may have encouraged these farmers to seek investment advice in order to increase their productivity and improve their efficiency.

Summary statistics using Irish FADN and FLINT data

The significance of the difference in means for the Irish FLINT sample of low extension services users (fewer than 8) and those which were categorised as medium and high users (8 or more), incorporating the sustainability indicators from the Irish FADN database was tested using either a t-test or chi square test. There were significant differences between the two groups for several of the indicators (Table 3). Low extension users had a lower output per hectare on average by approximately EUR 571 in comparison to their higher extension user counterparts. As with the FADN difference in means outlined earlier, the environmental indicators showed the opposite with low extension users faring better in both the GHG per hectare measure and nitrogen surplus per hectare. Low extension users received less agricultural training than the others in the sample, and worked over 226 hours fewer than medium and high extension users.

Table 4: Irish FADN extension coefficients for each regression with sustainability indicator as the dependent variable**.**

Indicator	Extension	SE	R-squared
Economic			
Output per ha	129.1**	55.41	0.634
Gross margin per ha	79.16**	33.33	0.649
Family farm income per labour unit	6,469***	1872.00	0.295
Viability	0.058*	0.034	0.268
Market orientation	0.0155**	0.01	0.608
Environmental			
GHG per ha	0.141	0.13	0.65
Nitrogen per ha	5.24	3.56	0.552
Social			
Household vulnerability	-0.053	0.04	0.139
Education	0.080**	0.03	0.189
Isolation	-0.000	0.03	0.037
Hours worked†	88.51*	50.37	0.228

N=872 except †N=871; robust standard errors reported for OLS
*** p<0.01, ** p<0.05, * p<0.1
Source: own calculations

In the following two sections the regression results for the Irish FADN and Irish FLINT data are outlined. The coefficients of the extension variables are presented for each of the OLS regressions conducted, along with standard errors and R-squared results. Full regression results are available from the authors.

Irish FADN

The results of the Irish FADN regressions given in Table 4 incorporate only questions which are part of the Irish FADN and NFS survey, including that outlining whether or not a farmer engaged with an extension service. These data include the full Irish FADN database of 877 farms, though outliers are excluded from the sample, as discussed previously, leaving 872 observations for all indicators except hours worked, which has 871 observations due to one farm not completing this question correctly. Although this paper focuses primarily on the extension variable, in summary the most statistically significant variables for each of the economic indicators include: farm system and number of residents in household. For the environmental and social indi-

cators the farm system dummy variables were statistically significant for each indicator.

These results indicate that participation in extension programmes has a positive impact on economic indicators, with all suggesting positive outcomes. Family farm income in particular is significant, with those who participate in extension programmes experiencing on average EUR 6,469 in additional farm income per labour unit. The environmental indicators suggest that those who participate in extension programmes have the poorest performance in terms of greenhouse gas emissions and risk of loss of nutrients to water (nitrogen per ha), though this result is insignificant. The results for the social indicators suggest that those who participate in extension schemes are more likely to be educated. On average, farmers who participate in extension schemes work 88.5 more hours per annum than those who do not.

Irish FLINT

Table 5 presents the supplementary Irish FLINT results for those who partook in extension activities fewer than eight times in 2015 (low extension) and 13 times or more in 2015 (high extension), incorporated into FADN and NFS data. These regressions are run only for those farms who participated in the FLINT study. One farm was excluded as an outlier, leaving 63 observations. As above, these results focus primarily on those of the extension variable; however the only determinants which were significant for the majority of the economic, environmental and social indicators were farm system.

The economic results indicate that low extension farms are significantly less viable than those that use extension services more frequently. The remaining economic indicator results suggest that these respondents have a lower output per hectare, lower family farm income per labour unit, are less likely to have market orientation and have a slightly higher gross margin per hectare, though these results are not statistically significant. Though the results for the environmental indicators are not statistically significant, they suggest that these farms have lower GHG and nitrogen emissions per hectare. In terms of social indicators, low extension households are statistically more likely to be vulnerable than those that use services more frequently and are less likely to be educated. These respondents are less likely to be isolated and would appear to work, on average, 166 fewer hours per annum than their more participatory counterparts, though these results are not statistically significant.

Though not significant for the majority of indicators, probably due to the small sample size, the results suggest that low participation rates with extension services have a negative influence on farming viability. The results for the environmental indicators are not statistically significant. In terms of social indicators, high extension households are statistically more likely to be educated. In contrast, low extension households are more likely to be vulnerable than their less engaged counterparts.

Discussion and conclusion

The literature on extension use has indicated that participation can have a positive impact on economic (Läpple *et al*., 2013; Cawley *et al*., 2015) social (Van den Berg and Jiggins, 2007) and environmental (Mancini *et al*., 2008) indicators of sustainability. While many of these studies focus on a specific extension service such as farmer discussion groups (Hennessy and Heanue, 2012; Bogue, 2014) and/or the impact of extension use versus no extension use (Cawley *et al*., 2015; Dillon *et al*., 2016), in general, little attention has been given to the range of extension service on offer, the sort of information that is requested and the level of engagement between the farmer and the extension provider. To the best of our knowledge, this is most likely due to the limited availability of data on these topics.

The results provided in this paper point to stark differences in the preferred extension service for each country in the European FLINT sample. In Ireland, Spain and Poland, public extension services provide the most frequent interaction with farming households; whereas in the Netherlands, Greece, Finland and Hungary private advisory services are most commonly used. This reflects the different policy frameworks across Europe. In Ireland, Teagasc is the primary advisory service for farmers providing advice on a

Table 5: Irish FLINT low and high extension coefficients for each regression with sustainability indicator as the dependent variable.

Indicator	Low extension			High extension		
		SE	R-squared		SE	R-squared
Economic						
Output per ha	-83.6	310.50	0.741	332.4	302.70	0.749
Gross margin per ha	6.775	180.30	0.748	197.80	173.50	0.756
Family farm income per labour unit	-5,040	8097.00	0.577	12,342	8,207	0.596
Viability	-0.230*	0.118	0.502	0.0743	0.115	0.364
Market orientation	-0.00874	0.02	0.882	0.0129	0.02	0.883
Environmental						
GHG per ha	-0.515	0.72	0.708	0.994	0.81	0.718
Nitrogen per ha	-28.75	19.20	0.685	34.71	22.25	0.692
Social						
Household vulnerability	0.312**	0.135	0.404	-0.192	0.129	0.258
Educated	-0.317**	0.145	0.371	0.309*	0.158	0.312
Isolation	-0.031	0.087	0.264	-0.0271	0.088	0.410
Hours worked	-166.6	178.30	0.361	180	181.50	0.364

N=63; robust standard errors reported for OLS; *** $p<0.01$, ** $p<0.05$, * $p<0.1$
Source: own calculations

wide range of issues including farm management, nutrition, investment and up-to-date research to fee-paying clients, with basic advisory contracts starting at EUR 145 per annum. This broad range of advice is reflected in the somewhat even spread of the type of information being requested. Over 50 per cent of farmers in the Irish sample requested information on issues related to accountancy, business, crop, livestock, animal welfare and investment opportunities.

In Spain, the type of advice being provided by public advisory services has changed in recent times, moving from their traditional role of personalised advice to farmers to focus primarily on the management of grants to farmers from CAP or other issues related to EU regulations (Esparcia *et al*., 2014). Again, this is represented in the type of information requested, with 86 per cent of farmers requesting information on accountancy issues but fewer than 50 per cent seeking information on any other issue. In Poland, the majority of advisory services became public in 1995, meaning that all farmers can now avail of free advice (Kania *et al*., 2014). The results from this paper indicate that this policy influences the uptake of services, as Polish farmers in the sample engage with public advisory services more frequently than any other country and Polish farmers are more likely to seek information on issues related to accountancy, business and crop production than in any other country.

One apparent outlier in terms of the number of engagements with advisory services is Greece. This country had by far the largest number of mean engagements with private advisory services and fewer engagements with public advisory services than any other country in the sample. This result is perhaps a reflection of the lack of funding and organisation for public agricultural advisory services in Greece. Over the last 30 years, the provision of public agricultural extension services in Greece has been limited and focused primarily on maximising outputs and subsidies to farmers rather than training and education. Though attempts were made in 2005 by the Ministry for Rural Development and Food (MRDF) to establish Local Centres for Rural Development, these Centres were closed in 2010 due to funding issues. All levels of the MRDF are understaffed and restrictions on travelling minimise the degree of contact possible between advisors and farmers. Owing to a lack of public advice, private advisors have become the main supporters of farmers. Some private advisors make a living by selling inputs to farmers. These advisors provide information on improvement of quality and quantity, cost reduction and environmental protection. Others are paid fees by farmers and provide information on participation in and application preparation for specific EU programmes (Young Farmers, Capitals for Early Retirement Scheme etc.) (Koutsouris, 2014). This focus on funding is reflected in the results in this paper, with 94 per cent of Greek farmers seeking information on accountancy issues.

The results of this analysis also highlight the type of information considered most valuable to farmers. In most of the surveyed countries, accountancy information was sought by the greatest majority of respondents. This is not surprising given the complicated processes involved in claiming benefits and due to new schemes such as the Basic Payment System, Greening and the Young Farmer's top-ups which came into effect in 2015. In Ireland, for example, many farm advisors have been overwhelmed with requests for assistance because of these additions (Coughlan, 2015).

The results also suggest that a large proportion of farmers requested advice on crop production. This could have arisen due to the introduction of the Greening payment in 2015. This payment obliges all farmers with 10 acres or more of arable crops (unless they qualify for an exception) to sow a number of different crops. Farmers with more than 15 acres of arable land must declare at least 5 per cent of their land as an 'Ecological Focus Area' (DAFM, 2015).

The Irish FADN and FLINT regression results outline the importance of engagement with extension services, and specifically the impact that greater degrees of engagement has on economic and social indicators, corresponding with the findings of Van den Berg and Jiggins (2007), Hennessy and Heanue (2012) and Bogue (2014). Though the Irish FLINT study consisted of only 64 cattle and dairy farms, these preliminary results suggest that lower engagement can have a detrimental impact on farm viability and household vulnerability in particular. However, these results are inconclusive as regards the influence of extension services on environmental indicators, with the difference in means analysis suggesting negative outcomes and the regressions providing insignificant results. It is possible that, at least in Ireland, economic indicators of sustainability are the primary focus of extension service providers and those who engage with them. This is reflected in the results of the Irish FADN regressions which suggest positive outcomes from engagement for all economic indicators and the type of information which is sought most by those in the Irish FLINT sample (accountancy and investment). These preliminary results highlight the need for specific extension services which focus on 'double dividend' economic indicators which also have environmental benefits, such as reducing agricultural emissions. Given the suggested positive results for economic indicators in this paper it is likely that engagement on environmental schemes of this kind could also be successful.

Despite the limitations of this research, the findings indicate that a large-scale FLINT study could prove very useful as a measure of farming sustainability throughout Europe. Future work of this kind could provide policymakers with information on the types of extension service that are most valuable to farmers in their country and with data on possible improvements to services that may be required. With this information in place, policymakers could anticipate the information burden that a new policy will place on farmers, and provide adequate expertise and education in these areas in advance of its introduction. This information could be used to measure the success of various extension services, information provision and specific national and EU policies in terms of their impact on economic, environmental and social indicators of sustainability.

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