FLINT

ADVISORY SERVICES AND FARM LEVEL SUSTAINABILITY

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ABOUT THE FLINT PROJECT

FLINT will provide an updated data-infrastructure needed by the agro-food sector and policy makers to provide up to date information on farm level indicators on sustainability and other new relevant issues. Better decision making will be facilitated by taking into account the sustainability performance of farms on a wide range of relevant topics, such as (1) market stabilization; (2) income support; (3) environmental sustainability; (4) climate change adaptation and mitigation; (5) innovation; and (6) resource efficiency. The approach will explicitly consider the heterogeneity of the farming sector in the EU and its member states. Together with the farming and agro-food sector the feasibility of these indicators will be determined.

FLINT will take into account the increasing needs for sustainability information by national and international retail and agro-food sectors. The FLINT approach is supported by the Sustainable Agriculture Initiative Platform and the Sustainability Consortium in which the agro-food sector actively participates. FLINT will establish a pilot network of approximately 1000 farms (representative of farm diversity at EU level, including the different administrative environments in the different MS) that is well suited for the gathering of these data.

The lessons learned and recommendations from the empirical research conducted in 9 purposefully chosen MS will be used for estimating and discussing effects in all 28 MS. This will be very useful if the European Commission should decide to upgrade the pilot network to an operational EU-wide system.

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3	MTT Agrifood Research Finland	Finland
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LIST OF ACRONYMS

AAS	Agricultural Advice Service
AKIS	Agricultural Knowledge and Innovation / Information System
AWU	Annual Working Units
CAP	Common Agricultural Policy
EC	European Commission
EFA	Ecological Focus Area
EU	European Union
ESU	European Size Unit
FADN	Farm Accounting Data Network
FAS	Farm Advisory Services
FLINT	Farm Level Indicators for New Topics
GHG	Greenhouse Gas Emissions
NUE	Nitrogen Use Efficiency
SCAR	Standing Committee on Agricultural Research
SME	Small and Medium Enterprise
OGA	Other Gainful Activities
PRO AKIS	Prospect for Farmers’ Support: Advisory Services in European AKIS
UAA	Utilized Agricultural Area

EXECUTIVE SUMMARY

This research aims to explore the use of advisory services and its linkages to the economic, environmental and social performance of farms. Using the FLINT sample of 1033 farms in nine countries (Germany, Greece, Finland, the Netherlands, Ireland, Hungary, Poland, Spain and France) we have explored the use of advisory services and their linkages with sustainability as measured through farm-level indicators. Results indicate that there exist differences in the number of contacts of farms with advisory services across countries, type of farms, farmers' degree of agricultural education, utilized agricultural area, legal type of farm ownership and economic size of the farms. The number of contacts with advisory services is positively related with the adoption of innovation, measures of farm diversification, and the number of sources of information utilized at the farm level. With regard to economic sustainability indicators, there is a number of significant correlations with farm contacts with advisory services. Also correlations with environmental and social indicators were identified but causality chains were not determined. Overall, results suggest the importance of taking into account the heterogeneity of both the farming systems and the advice providing systems to assess the role of advisory services in farm-level sustainability.

1 INTRODUCTION

A growing pressure on economic performance, increasing competition, societal demands, and changing legal frameworks require adaptation of agricultural production systems and timely adjustments in farm management. Farmers all over the European Union (EU) need access to relevant and reliable knowledge to cope appropriately with these multiple challenges in a continuously evolving environment. With the help of the comprehensive concept of 'Agricultural Knowledge and Innovation Systems' (AKIS), a broad range of actors can be identified that have the potential to support farmers' performance by making information available. Thus, the AKIS concept is widely used to address knowledge infrastructures and flows related to the sector or its specific branches (Knierim et al. 2015) and to specifically focus communication and interaction among multiple actors in agricultural innovation processes (EU SCAR 2012; EU SCAR 2013). However, agricultural advisory services are still the most prominent instrument in this regard (Hoffmann et al. 2009; Labarthe 2009; Rivera and Sulaiman 2009), in particular because of their institutionalization as 'Farm Advisory Services' (FAS) in the EU member states (EC 1782/2003). Here, we understand agricultural advisory services (AAS) as "the entire set of organisations that will enable the farmers to co-produce farm-level solutions by establishing service relationships with advisers so as to produce knowledge and enhance skills" (Labarthe et al. 2013). In order to promote rural development and agricultural innovation, advisory services specifically are mentioned in the objectives of the current Common Agricultural Policy (CAP) (2014 – 2020) as innovation support services aiming to improve co-operation and sharing of knowledge (EC 1305/2013). Member states are encouraged and entitled to EU co-funding to set up and/or improve advisory services to support rural actors (farmers, small and medium enterprises-SMEs) to improve the sustainable management and overall performance of their holding or business. However, monitoring and evaluation of the effects and impacts of advisory services are fragmented and there is still an overall lack of data and research for evidence-based policy (Labarthe et al. 2014; SCAR 2016).

Advisory work is seen as key in farm-level problem solving processes, for the provision of information and in the support of change and innovation (Hoffmann et al. 2009). However, the knowledge about the effectiveness and the impact of such services remains fragmented, which can be attributed to two reasons, mostly. On the one hand, there is the complexity of the influencing factors on the service relationship as such that makes standardized evaluations nearly impossible. On the other hand a huge diversity of organizational settings across the EU member states has to be acknowledged that renders a cross-cutting analysis very challenging. The evaluation of the FAS in 2009 was – to our knowledge - one of the very few if not the only pan-European study on agricultural advisory services; although not exhaustive as it addressed only the services related to the Direct Payments directive (EC 1782/2003) (ADE 2009). Interestingly, this overview revealed the organizational diversity of agricultural service providers, which was also confirmed by the EU wide survey of the PRO AKIS project (www.proakis.eu). Largely, advisory organisations can be grouped into public, private, farmer-based and other non-governmental service providers, and in the case presented here, even expanded to upstream and downstream industries providing commercial advice. Although the latter is frequently excluded from such studies because of the strong tendency of biased information, the FLINT project explicitly encompassed all stakeholders' interests along the value chain and thus here, we include this actor group also for advisory services.

A number of case studies and targeted comparative research have indicated that there are some structural features related to farmers that make more frequently use of professional advice than others. In these cases, relatively more highly educated farmers on larger farms are more likely to demand advice, while small scale farmers are less frequently target groups of advisory services and hence, have less access to such knowledge. A study focusing on the privatized advisory services in Brandenburg, Germany, on cross compliance extension has shown that farmers receiving advisory services are better informed, and feel more secure about cross compliance (Knierim et al. 2011). The assessments of effectiveness of extension services have shown mixed results in technology adoption behaviour or economical returns. In the absence of panel data and the difficulty to identify control groups, methods

such as endogenous switching regression models (Läpple et al., 2013) or propensity score matching analysis have been used to evaluate extension services (Läpple and Hennesy, 2015).

The FLINT project tries to contribute in to close this gap while collecting additional data from a sample of farmers of the Farm Accountancy Data Network (FADN) in nine EU countries (The Netherlands-NL, Hungary-HU, Finland-FI, Poland-PL, Spain-ES, Ireland-IE, Greece-GR, France-FR and Germany-DE). The data set includes accountancy data from FADN (here after: 'FADN data'), as well as additional data on economic, environmental and social sustainability of farms. These additional data, the 'FLINT data', were collected via face-to-face survey or merging of existing data, depending on the country. The FADN and FLINT data relate to accountancy year 2015, except for France and Germany for which it is 2014.

This case study aims to explore the use of advisory services by the farmers of the FLINT sample and their linkages with farm-level economic, environmental and social performance. With that purpose, description of the advisory service providers and their respective services, linkages with sustainability indicators and profiling of advice-taking farms are presented.

2 METHODOLOGY AND DATA

Advisory service is defined as “*the process whereby the advisor aims to motivate and enable the client to solve his/her acute problems”* (Albrecht et al. 1987, Hoffmann et al. 2009). Advisory services are provided mainly through communicative interventions that facilitate the access to information, knowledge and interaction with other actors, where the clients’ freedom and responsibility to make decisions and implement solutions is preserved (Leeuwis and van den Ban 2004; Christoplos 2010; Hoffman et al. 2009).

Within the FLINT questionnaire, we operationalized ‘farm-level advisory services’ by the total number of contacts with advisory services per year, the organizational type of advisory service providers and the range of themes on which farms seek advice (type of advice). The questionnaire included six **types of providers**: public advisors, private advisors, cooperatives, farmers based providers, upstream and downstream companies and others. Also, the **type of advice** was asked for according to eight themes which were identified according to the topics described in the FADN farm return: accountancy, management, crop production, animal production, animal products, other gainful activities, investments and others.

The analysis of the data is based on the following three main steps: (i) preparation of the database, (ii) description of the variables and their linkages with advisory services and (iii) analyses by farm groups.

The preparation of the database included the selection of variables, the computation of new variables and identification of 13 outliers (farms which reported more than 160 contacts per farm per year) which were not included in the analysis. For a better comparison between farm types and countries, but also with sustainability aspects, aggregated advisory services variables were created by merging the ‘type of advice’ in three major categories: ‘advice for production’, ‘advice for management/financial-related issues’ and ‘others’. Based on calculations, two more variables were created: ‘number of providers per farm’ and ‘number of types of advice per farm’. Personal characteristics of the manager (gender, education grade and age) were computed identifying the manager in the FADN data as the person who reported the largest number of annual working hours on the farm. Table 1 and 2 include the definition of variables used.

In order to explore the differences in the use of advisory services and considering the non-normality of the data, mean comparisons (Kruskal-Wallis) and cross tabulations (X^2 or Fishers test) between advisory service variables and farm variables were used. The relationships between advisory service and sustainability indicators were explored using correlations (Spearman correlations) according to farm types. Identified heterogeneity of the sample was analyzed separating the sample by quartiles of number of advice contacts per year and identifying clusters of farms according to the selected variables. The cluster analysis was made using 5 standardized selected indicators with zero or low correlations between them by means of both hierarchical and non-hierarchical methods. Identified groups were compared using the farm profile characteristics and sustainability indicators. With the analysis, it is not possible to infer the causal chain from advisory services over farm practices to sustainability outcomes, because we did not account for changes across several years nor have used counterfactual scenarios. However the information could be used as a base-line for future ex-post evaluations.

Table 1. Variables used

Variable definition (units/categories)	FLINT or FADN code
Advisory service related	
Total number of contacts with advisory services (number)	S_1_1
Number of contacts with advisory service related to accountancy, management or investments* (number)	AS_CAT1ACCOUNT
Number of contacts with advisory service related to crop and animal production and animal products* (number)	AS_CAT2PROD
Number of contacts of advisory service related with other gainful activities (OGA) and others*(number)	AS_CAT3OTHER
Number of providers used per farm* (number)	ASV1017
Number of types of advice used per farm* (number)	ASV1020
Farm profile	
Utilized Agricultural Area (ha)	SE025
Country (Categories: NL=The Netherlands; HU=Hungary; FI= Finland; FR=France; PL=Poland; ES= Spain; IE= Ireland; GR= Greece; DE= Germany)	COUNTRY_ID
Type of farming (Categories: 1=field crops; 2=horticulture; 3=wine; 4=other permanent crops; 5=milk; 6=other grazing livestock; 7=granivores; 8=mixed farms)	TF8
Economic Size Groups according to Standard Outputs** (Categories: 1=2,000 - < 8,000 EUR; 2=8,000 - <25,000 EUR; 3=25,000 - <50,000 EUR; 4=50,000 - <100,000 EUR; 5=100,000 - <500,000 EUR; 6=>= 500,000 EUR)	ESGCLASS
Type of ownership (Categories: 1=family farm; 2=partnership; 3=company)	A_CL_110_C
Manager characteristics	
Age of the farm manager*** (years)	YEARS_ MANAGER
Sex of farm manager*** (Categories: 1=male; 2=female)	GENDER_MANAGER
Degree of agricultural education of farm manager*** (Categories: 1=only practical agricultural experience; 2=basic agricultural training; 3=full agricultural training)	EDUCATION _MANAGER

*Indicators computed from FLINT gathered data

** The standard output of an agricultural product (crop or livestock) is the average monetary value of the agricultural output at farm-gate price, in euro per hectare or per head of livestock. The sum of all the standard outputs per hectare of crop and per head of livestock for a farm is a measure of its overall economic size, expressed in euro (Eurostat, 2016).

***Farm manager: In farms where more than one manager is reported, we considered for the analysis the one who stated the most working hours on the farm.

Source: the authors

Table 2. Sustainability indicators used

Indicator definition (units)	FLINT or FADN code
Environmental	
Share of permanent grassland under intensive management (%)	E_1_1
Share of permanent grassland that is extensively managed with semi-natural vegetation	E_1_2
Weighted percentage of catch crop within farm utilized agricultural area (UAA) (%)	E_10_3
Percentage of farm UAA with nitrate risk (%)	E_10_4
Percentage of farm UAA associated with erosion risk (%)	E_11_1
Percentage of farm UAA with erosion mitigation (%)	E_11_8
Greenhouse gases (GHG) emissions, at farm level (tonnes CO_2 equivalent)	E_14_1
Water consumption /kg of product (m^3/kg)	E_16_1
Crop species diversity (index)	E_18_1
Share of potential ecological focus area (EFA) area on farms with arable area (%)	E_2_2
Pesticide usage (kg/ha)	E_4_1
Farm gate N balance (kg)	E_5_1
Nitrogen use efficiency (NUE) (total N output *100 / total N input)	E_5_3
Economic	
Total support for rural development (EUR)*	SE624
Other rural development payments (EUR)**	SE623
Gross farm income (EUR)	SE410
Family farm income (EUR)	SE420
Farm net value added/AWU (EUR)	SE425
Total labour in AWU (AWU)	SE010
Age of machinery (years)	EI_6_1
Adoption of farm diversification (Categories: 0=no adoption; 1=adoption)	EI_9_1
Adoption of credit avoidance (Categories: 0=no adoption; 1=adoption)	EI_9_4
Adoption of contracts (Categories: 0=no adoption; 1=adoption)	EI_9_7
Innovation at farm level (Categories: 0=no innovation adopted and 1=adoption of innovation)	EI_1_4
Social	
Number of sources of information (number)	S_1_4
Number of persons participating in training events	S_2_5
Years of experience as manager	EI_4_2
Working hours per week of manager (hours)	S_5_18
Satisfaction with work-life balance (scale from 0 to 10)	S_6_2
Satisfaction with quality of life (scale from 0 to 10)	S_6_4
Stress perception (scale from 0 to 10)	S_6_6
Social diversification index (number)	S_7_2

*Environmental subsidies + Less Favoured Areas subsidies + other Rural Development payments including Rural Development national payments.

**Support to help farmers to adapt to standards, to use farm advisory services, to improve the quality of agricultural products, training, afforestation and ecological stability of forests

Source: the authors

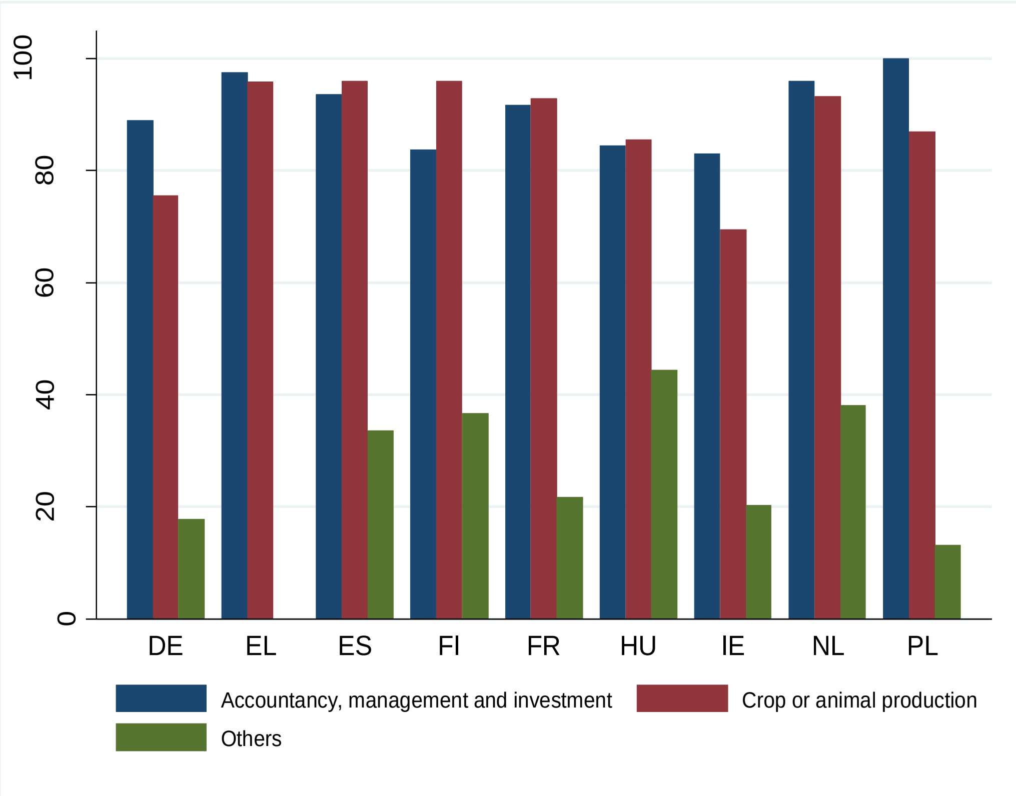
3 RESULTS

3.1 Use of advisory services by farmers

3.1.1 Number of advisory contacts and types of advice

Regarding to the outreach of advisory services, almost each farm in the sample (N=1033) had contact with advisory services: only 36 farms of the sample report not receiving advisory services. In all member states, more than 80% of the farms are in contact with advisory services related to accountancy or business management (for Poland even 100%). Besides, more than70% of all farms has additionally contacts related to crop or animal production (see Figure 1). Finland, Spain, France and Hungary have a higher percentage of farms contacting advisory services for production related issues than for accountancy related ones. Except for Greece, other type of advice (other gainful activities) is used between 17 and 40% of the farms.

Figure 1. Percentage of farms using advisory services, per type of advice



Source: the authors

The frequency and number of contacts with farm advisory services vary according to the broad themes of advice. On average, each farm has annually 26.86 contacts with advisory services of which 15.95 are advisory services related to crop or animal production and nearly 11 on management / financial issues. This fact could perhaps indicate the need of farmers to comply with the wider scope of cross compliance for good agricultural and environmental conditions. However, there are differences among countries

(Table 3). Countries with a high number of contacts on production issues are the Netherlands (23.08), France (18.82), Poland (17.17), Greece (17.69) and Hungary (13.62). Poland shows a relative high amount of management contacts (17.32) as well.

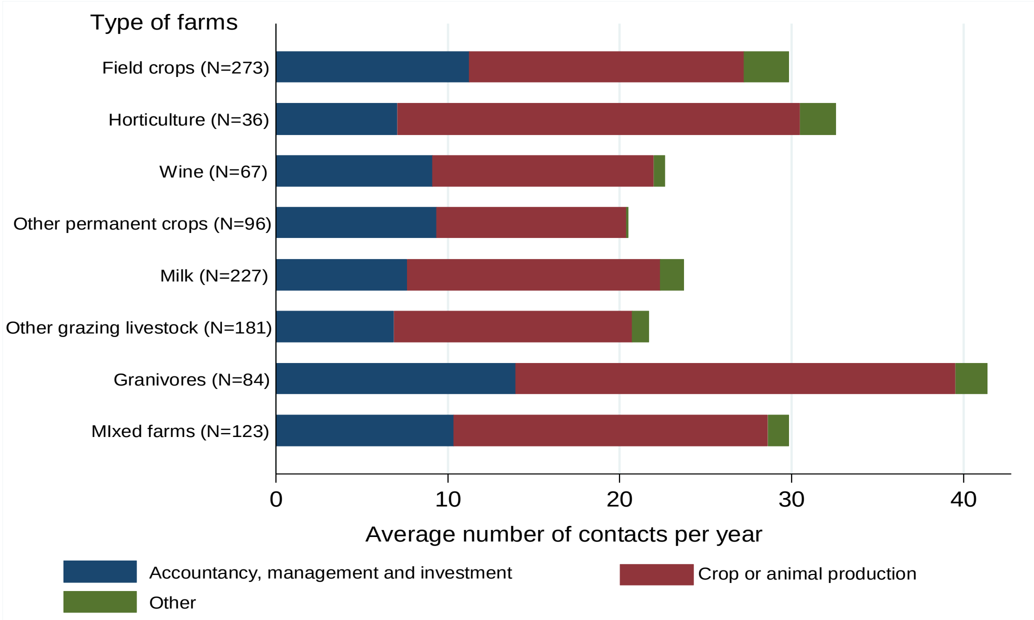
Table 3. Number of annual contacts with advisory services, per type of advice

	Type of advice											
	All contacts			Contacts relating to crop and animal production			Contacts relating to accountancy, management and investment			Other contacts		
	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N
Germany	12.71	12.49	45	6.07	7.48	45	6.27	7.43	45	0.38	1.11	45
Greece	26.31	24.36	120	17.69	19.61	120	8.63	8.56	120	0.00		120
Spain	21.05	13.16	125	11.31	10.25	125	7.79	6.11	125	1.94	3.47	125
France	28.80	28.88	253	18.82	19.79	253	8.77	12.63	253	1.20	4.28	253
Finland	17.41	21.57	49	10.20	13.37	49	5.57	7.71	49	1.63	4.29	49
Hungary	26.33	21.99	90	13.62	13.17	90	9.52	11.28	90	3.19	6.01	90
Ireland	11.41	7.84	59	5.11	5.77	59	5.03	5.25	59	1.25	3.58	59
Netherlands	35.14	27.26	147	23.08	19.20	146	8.65	8.44	147	3.40	8.37	147
Poland	34.77	27.07	145	17.17	17.60	145	17.32	13.26	145	0.28	1.11	145
Total	**26.86**	**24.98**	**1033**	**15.95**	**17.35**	**1033**	**9.41**	**10.76**	**1033**	**1.49**	**4.70**	**1033**
Test of equality of means	p = 0.0001 Chi-squared= 116.102 with 8 d.f.			p = 0.0001 Chi-squared= 112.502 with 8 d.f.			p = 0.0001 chi-squared = 146.35 with 8 d.f.			p= 0.0001 chi-squared = 59.44 with 8 d.f.		

Source: the authors

There are also differences in advice contacts according to the type of farms. Intensive farming systems such as granivores (poultry and pigs) and horticulture have on average more contacts than all other farms (41 and 32, respectively). On the other hand, farms specializing on cattle and sheep (other grazing livestock) and other permanent crops on average have the lowest number of contacts per year (Figure 2).

Figure 2. Number of annual contacts with advisory services, per type of farm and type of advice



Source: the authors

Differences in the number of contacts cannot only be observed by type of farms but also by the characteristics of the farm or the farm's manager (Table 4). Farmers with full agricultural training have significantly more contacts with farm advisory services than farmers with less education. Moreover, companies and large farms have more contacts with advisory services than family farms. Farms of small economic size (2,000 to 50,000 EUR) have less often contact than larger ones; and the number of contacts increases stepwise with the economic size of the farm.

Table 4. Comparison of means of the number of advice contacts per year

	Characteristics	Mean	SD	N	Test of equality of means
Sex of manager	Male	26.42	24.86	889	p=0.7814 Chi-squared 0.077 with 1 d.f.
	Female	26.52	26.98	85	
Education	Only practical agricultural experience	22.87	21.56	301	p=0.0065 Chi-squared 12.101 with 2 d.f.
	Basic agricultural training	26.78	26.99	280	
	Full agricultural training	28.88	25.81	393	
Type of Ownership	Family Farm	24.27	23.10	721	p=0,0001 Chi-squared 27.910 with 2 d.f.
	Partnership	32.38	27.90	254	
	Company	34,87	28.54	58	
Economic Size group	2,000 - < 8,000 EUR	10.41	7.31	17	p=0.0001 Chi-squared=88.972 with 5 d.f.
	8,000 - <25,000 EUR	16.05	13.44	117	
	25,000 - <50,000 EUR	20.83	17.46	160	
	50,000 - <100,000 EUR	25.39	23.59	220	
	100,000 - <500,000 EUR	29.19	26.13	404	
	>= 500,000 EUR	43.33	32.27	115	

Source: the authors

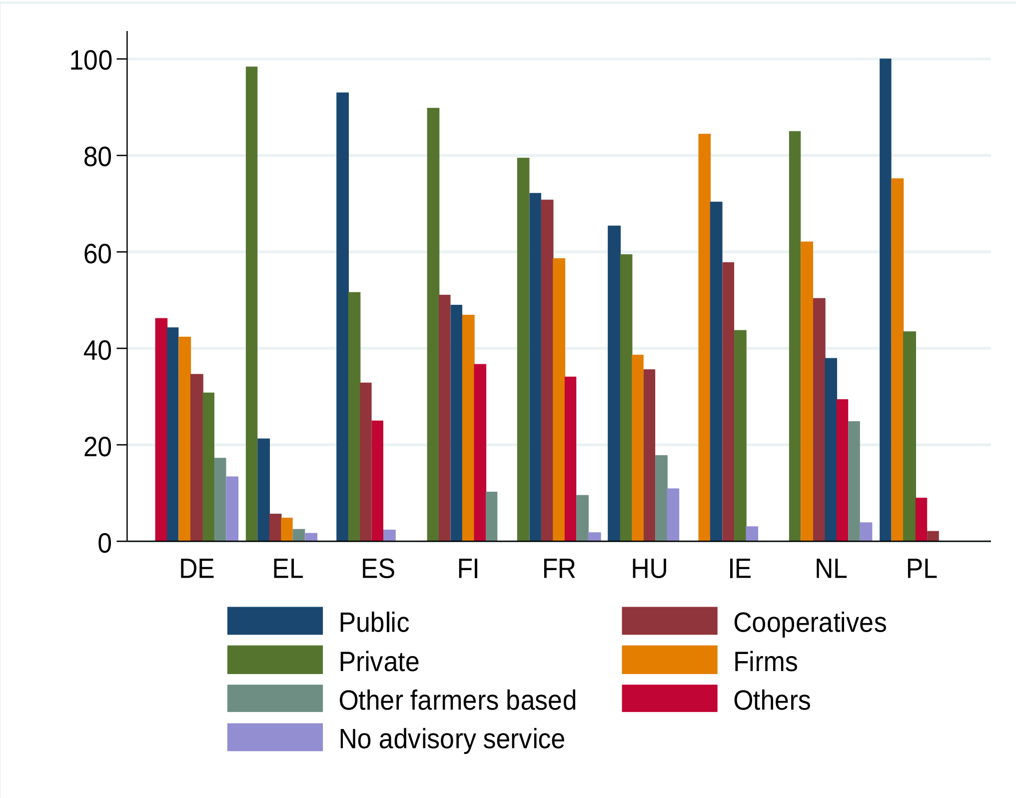
3.1.2 Providers of advisory services

The ‘organizational landscape’ of what type of service providers farm managers contact, differs across countries as well. Regarding the presence of different providers of advisory services, out of the six possible types of advisory service providers, farms report contacting 2.5 types on average. A higher average of providers is reported for farms in France (3.24), the Netherlands (2.88) and in Finland (2.84). In the overall FLINT sample, 68% of the farmers reported having contacts with private advisors, followed by public advisors (65%) and upstream and downstream companies (47%).

Public advisors are more often contacted in Spain, Poland and Hungary, while in Greece they are less often contacted. Private advisors support and work closely with farmers in Greece, Finland, France and in the Netherlands. Companies cooperate predominantly with farmers in Ireland, in Poland and in the Netherlands. Farmer’s cooperatives and other farmer based providers have linkages with farmers and provide specific advisory services in Ireland, Finland, France and in the Netherlands.

There are differences according to the structure of advisory services across countries. Figure 3 shows that in Germany, there is a quite balanced use of the different advisory services providers. In Greece (almost 100%), Finland (almost 90%) and the Netherlands (around 80%), private advisory providers dominate, and in Poland, Spain, Ireland and Hungary, the predominant providers are public (100%, 93%, 71%, and 65% respectively). Cooperatives were mentioned most often in France (70%) and Ireland (53%), where also private firms are most often contacted (more than 80%) by the farms. The fact that 100% of Polish farms contact public advisory services can be explained through the fact that the advisors from the public advisory service collected the FLINT data. In Greece, almost no public advisory service is available for the farms represented in the sample.

Figure 3. Percentages of farms having contacts with different advisory service providers, by country



Source: the authors

3.2 Linkages of advisory services and the three pillars of sustainability

The linkages of advisory services and the three pillars of sustainability at farm level were explored statistically with the help of correlation analysis. Using the indicators described in Table 2, we have correlated the number of total advice contacts (code S_1_1) with the economic and social indicators. Linkages with environmental indicators were explored using the number of total advice contacts related with crop and animal production only (code AS_CAT2PROD), referring to the hypothesis that mainly technical advice would contribute to improve the environmental sustainability of a farm. In this section we present the results of the statistical calculations.

3.2.1 Advisory services and link to economic sustainability

In the total sample, there is a positive and significant relation between gross farm income and the number of contacts for advisory services (r=0.2022). This correlation is however not the same for all farm types: it is higher for other permanent crops (r=0.5283) and wine (r=0.4024) and not significant for horticulture, sheep and mixed farms. Farms who have more labor input per year also have more contacts with advisory services (r=0.2910) and that is true for field crops, permanent crops, milk and other grazing livestock farms. There is not a significant correlation between net value added per annual working unit (AWU) and the number of contacts with advisory services (Table 6).

With regard to family farm income and advisory contacts, the results do not show a clear direction for interpretation (Table 6). Additionally, the results suggest that for milk and mixed farms, the number of advisory contacts decreases with the increase of the age of machinery.

Studying the links between the total value of subsidies for rural development (SE624) and advisory services, no significant correlations emerged. Similarly, studying other rural development payments (code SE623) and the link with rural advisory contracts, no significant results can be observed either (see Table 6). This can be explained by the low number (24%) of farms included in the FLINT sample, receiving subsidies for adopting standards, using farm advisory service or training (code SE623).

For the economic categorical indicators, a comparison of means was undertaken to identify linkages between farm practices and number of advisory contacts. On average, farms with more advisory contacts are more diversified, have more production contracts, adopt more innovations and are less reluctant in taking credits (Table 5).

Table 5. Mean comparison of the number of advisory services contacts by adoption of farm innovation and risk management practices

Farm practice	Adoption of innovation or risk management practice						Test of equality of means
	Yes			No			
	Mean	SD	N	Mean	SD	N	
Diversification	30.17	26.62	490	23.88	23.01	543	p=0.0001 Chi-squared 22.631n with 1 d.f.
Credit avoidance	24.94	23.51	446	28.32	24.94	587	p=0.0002 Chi-squared 4.516 with 1 d.f.
Production contracts	37.15	31.78	289	22.86	20.44	744	p=0.0001 Chi-squared 58.971 with 1 d.f.
Innovation at farm level	31.92	28.34	431	22.25	21.57	602	p=0.0001 Chi-squared27.642 with 1 d.f.

Source: the authors

3.2.2 Advisory services and link to social sustainability

The indicators considered for social sustainability can be grouped into those with a direct link to advisory services and knowledge increase and others. The first group includes 'number of sources of information on CAP' (S_1_4), and 'number of persons participated in training events' (S_2_5). With regard to these first indicators, in five out of eight farm types, the number of contacts with advisory services is positively correlated with the number of information sources on CAP (r=0.2306) (Table 6). The general weak linkages between the number of advisory contacts and persons trained can be explained by the fact that only 215 farms reported one or more persons trained during the last year. For horticultural farms only, there is a significant positive link between persons trained and contacts with advisory services (r=0.5127) while for granivores this relation is significantly negative (r=-0.3151). Regarding the agricultural education, we have seen in the previous chapter that the more educated farm managers usually hold more contacts with advisory services; however, no significant relationship was found with the years of experience of the manager.

Beyond information and education-related indicators, links with other social aspects are very heterogeneous and difficult to interpret. Farms with more advisory service contacts are part of a higher number of organizations or community initiatives (r=0.1198). Surprisingly, farms with more advisory service contacts report higher level of stress (r=0.1278), more working hours per week (r=0.1811) and lower satisfaction with their work-life balance (r=-0.1325) (Table 6). Whether or not any cause-effect relations exist in all these cases cannot be determined on the basis of the existing data. However, a more differentiated analysis could give more clarity as the results differ when separating the sample by farm type. For example, the negative relationship between the number of advisory contacts and work-life balance satisfaction is only true for wine farms, other grazing livestock farms and mixed farms, and the positive stress perception correlation is significant for milk farms, other grazing livestock farms and mixed farms.

FLINT

Table 6. Correlation coefficients between the total number of contacts of advisory services and social and economic indicators, by type of farm

Indicator	Code	All farms	Type of farms: Field crops	Horticulture	Wine	Other permanent crops	Milk	Other grazing livestock	Granivores	Mixed farms
		1033	254	35	65	94	216	175	79	115
Economic indicators										
Gross farm income	SE410	0.2022*	0.2457*	0.4576	0.4024*	0.5283*	0.1844	0.0703	0.2269	0.1686
		1033	254	35	65	94	216	175	79	115
Family farm income	SE420	0.0196	0.115	0.4695	0.3328	0.2853	-0.0781	-0.0221	0.0304	-0.1283
		1033	254	35	65	94	216	175	79	115
Farm net value added / AWU	SE425	0.0203	0.1237	0.3412	0.2873	-0.0686	-0.0141	-0.0761	0.1333	-0.0767
		1033	254	35	65	94	216	175	79	115
Total labour input	SE010	0.2910*	0.2277*	0.3705	0.2844	0.5732*	0.3175*	0.3114*	0.2647	0.2363
		1033	254	35	65	94	216	175	79	115
Average age of machinery	EI_6_1	-0.1519*	-0.0695	0.1987	-0.0518	-0.1864	-0.2343*	-0.1177	-0.1917	-0.3847*
		1011	249	34	65	93	213	170	76	111
Total support for rural development	SE624	-0.0434	0.1414	0.2549	-0.0658	0.2288	-0.1419	0.0303	-0.0332	0.1711
		1033	254	35	65	94	216	175	79	115
Other rural development payments	SE623	-0.0729	0.0899	.	0.0719	0.1358	-0.1207	-0.1661	-0.1586	0.0522
		1033	254	35	65	94	216	175	79	115
Social indicators										
Number of sources of information	S_1_4	0.2306*	0.2665*	0.5258*	-0.2545	0.4015*	0.2496*	0.1124	0.1286	0.2779*
		972	252	27	54	71	215	164	76	113
Number of persons participating in training events	S_2_5	0.0503	0.1213	0.5127*	0.5118	0.3065	0.0221	0.0965	-0.3151*	0.0439
		320	65	21	14	26	85	24	42	43
Years of experience as manager	EI_4_2	-0.0518	-0.1231	-0.4807	0.1524	-0.1022	0.1352	-0.0395	-0.1774	-0.1485
		820	209	13	65	89	144	145	53	102
Working hours per week	S_5_18	0.1811*	0.1558*	0.4339	-0.1519	0.5516*	-0.0143	0.1101	0.3823*	0.2815*
		860	226	14	65	92	151	146	59	107
Satisfaction with work-life balance	S_6_2	-0.1325*	-0.0889	-0.228	-0.3110*	-0.0701	-0.1261	-0.2768*	0.1524	-0.1851*
		1027	254	35	65	94	215	173	78	113
Satisfaction with quality of Life	S_6_4	-0.0405	0.0077	0.2079	-0.1897	-0.0513	-0.0806	-0.2530*	0.2544*	0.0734
		1006	247	25	65	94	209	174	78	114
Stress perception	S_6_6	0.1278*	0.0946	-0.019	-0.033	0.0707	0.1466*	0.2526*	0.117	0.2283*
		1017	252	34	65	93	208	172	79	114
Social diversification index	S_7_2	0.1198*	0.1764*	0.5780*	0.1557	0.1039	0.1099	-0.0085	0.157	0.0634
		1033	254	35	65	94	216	175	79	115

* p value<0..05

Source: the authors

3.2.3 Advisory services and links to environmental sustainability

For the environmental sustainability analysis, 13 out of 32 indicators were selected, based on the aim to choose those relevant for all farm types and representing all dimensions of environmental sustainability.

Linkages between advice contacts and environmental sustainability were analyzed considering the number of farm advice on production issues, referring to the hypothesis that the technical advice contributes to sound environmental farming while accountancy and management contents do not play a role. Differences could be observed according to farm types. However, the results need to be taken with care due to the low number of cases (Table 7).

For the **field crop** farms, the more advisory contacts they report, the higher the percentage of farm area with catch crops is reported too (r=0.2655), and the higher is the farm gate N balance (r=0.2928).

For **other grazing livestock** farms, the more contacts farmers have with advisory services, the larger the share of permanent grassland under extensive management (r=0.277); for **milk farms,** the lower percentage of farm area under nitrate risk is observed, the more advisory contacts these farm types report (r=-0.2945).

For horticulture farms**,** the only significant correlation refers to greenhouse gases (GHG) emissions: those farms having higher GHG emissions at farm level, have more advisory contacts (r=0.6397).

As a summary, from the results we can see highly mixed correlations. Some farm types have a positive correlation between the number of advisory contacts and environmental indicators while other farm types show mixed results (positive and negative correlations). These results raise questions about plausible relationships and thus call for further causality research especially regarding agricultural practices and their impact.

Table 7. Correlation coefficients between the number of advisory contacts for crop and animal production per year and environmental indicators

Indicator	Code	All farms	Type of farms: Field crops	Horticulture	Wine	Other permanent crops	Milk	Other grazing livestock	Granivores	Mixed farms
		1033	254	35	65	94	216	175	79	115
Share of permanent grassland under intensive management	E_1_1	-0.0978	-0.0403	-0.5238	0.087	0.1141	-0.1842	-0.2347	0.2024	-0.1314
		820	214	10	61	39	179	166	51	100
Share of permanent grassland that is extensively managed with semi-natural vegetation	E_1_2	0.0936	0.1648	0.2495	0.0796	0.1549	0.16	0.2777*	-0.4363	-0.0645
		820	214	10	61	39	179	166	51	100
Weighted percentage of catch crop within farm UAA	E_10_3	0.2083*	0.2655*	0.2696	-0.0084	0.1456	0.1918	0.0134	0.2336	0.2431
		1019	254	35	65	94	216	175	66	114
Percentage of farm UAA with nitrate risk	E_10_4	-0.1907*	-0.1677	-0.252	0.0192	-0.1018	-0.2945*	-0.1813	-0.2014	-0.1593
		1019	254	35	65	94	216	175	66	114
Percentage of farm UAA associated with erosion risk	E_11_1	-0.0408	0.1	.	0.077	0.181	-0.1436	0.0871	-0.1982	-0.0039
		183	43	0	22	27	34	25	7	25
Percentage of farm area with erosion mitigation	E_11_8	0.0899	0.1408	.	-0.0845	0.3475	0.0995	0.0168	0.6171	-0.1585
		183	43	0	22	27	34	25	7	25
GHG emissions. at farm level	E_14_1	0.0818	0.1308	0.6397*	0.8857	0.22	0.2275	-0.1652	0.4062	0.3707
		676	159	33	6	92	156	101	52	77
Direct blue water footprint (kg) water consumption /kg of product.	E_16_1	0.1258*	-0.0152	-0.021	0.1488	0.3143	0.2312	0.1533	0.0461	0.0036
		843	229	12	61	68	184	111	74	104
Crop species diversity	E_18_1	0.1949*	0.1931	0.3605	0.0534	0.0896	0.18	0.2352	-0.0268	0.1549
		1019	254	35	65	94	216	175	66	114
Share of potential EFA area on farms with arable area	E_2_2	0.1721*	0.2125	0.2729	0.1308	.	0.1179	0.2154	0.0212	0.2279
		1033	254	35	65	94	216	175	79	115
Pesticide Usage	E_4_1	0.0602	0.0809	-0.0258	0.3105	0.0322	0.2169	0.2397	-0.1001	0.1529
		653	207	24	50	65	118	51	50	88
Farm Gate N-Balance	E_5_1	0.2407*	0.2928*	0.2191	0.7143	0.208	0.1801	-0.0251	0.2433	0.3483
		676	159	33	6	92	156	101	52	77
Nitrogen use efficiency (NUE)	E_5_3	0.0184	-0.1235	0.1666	-0.7143	0.0057	0.1409	-0.067	-0.2425	-0.0584
		665	157	31	6	85	156	101	52	77

* p value<0.05

Source: the authors

3.3 Profiling users of advisory services

As presented already in Table 3, the total number of contacts with advisory services (S_1_1) differs strongly according to the farm characteristics. Despite an average of 26.86 contacts per year, half of the total sample has 19 or less advisory contacts per year. Therefore, to analyze different farm groups we first compared the number of advisory service contacts by quartiles. Next, we conducted a cluster analysis using the number of advisory service contacts, two environmental indicators and two economic indicators. Results from these comparisons are presented in this section.

3.3.1 Advisory service contacts quartiles

The first analysis by groups separates the sample according to the quartiles of the total number of advice contacts per year. The first quartile has on average 6.22 contacts per year with advisory services and only 2.80 contacts per year with advisory services related with crop or animal production. The fourth quartile has on average 61.77 contacts per year, of which 37.90 are related to crop or animal production.

As seen in Table 8, quartiles 1 and 2 have less utilized agricultural area (UAA) on average, a larger share of small farms, a larger proportion of family farms and a larger proportion of managers with only practical agricultural experience.

Table 8. Profile of farms by quartiles of number of contacts of advisory services

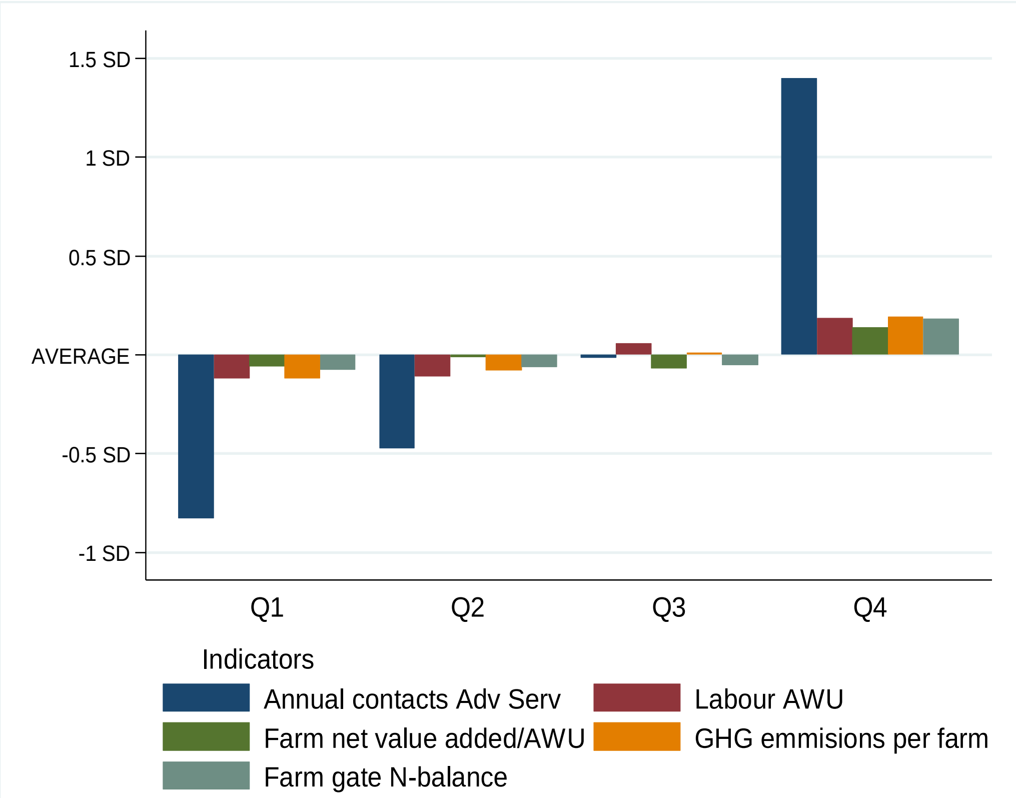
	Quartile 1 N=294	**Quartile 2 N=233**	**Quartile 3 N=250**	**Quartile 4 N=256**	**All farms N=1033**	Test of equality of means/proportions
Number of advisory contacts per year per holding (mean)	6.22	15.03	26.42	61.77	26.86	0.0001
Number of contacts with advisory service related to accountancy, management or investments (mean)	2.80	6.32	9.08	20.14	9.41	0.0001
Number of contacts with advisory service related to crop and animal production and animal products (mean)	3.01	8.14	15.98	37.90	15.96	0.0001
Number of providers used per farm (mean)	2.0	2.42	2.69	3.25	2.57	0.0001
Utilized Agricultural Area in ha (mean)	63.18	65.18	128.52	143.03	99.23	0.0001
Economic Size Group based on Standard Outputs (%)						0.0000
2,000 - < 8,000 EUR	70.59	17.65	11.76	0	100	
8,000 - <25,000 EUR	41.88	27.35	22.22	8.55	100	
25,000 - <50,000 EUR	32.50	30.0	22.50	15.00	100	
50,000 - <100,000 EUR	29.09	23.64	25.0	22.27	100	
100,000 - <500,000 EUR	25.25	20.30	25.74	28.71	100	
>= 500,000 EUR	13.04	13.91	23.48	49.57	100	
Type of ownership (%)						0.0000
Family farms	31.21	24.27	23.16	21.36	100	
Partnerships	21.65	20.47	26.77	31.10	100	
Commercial farms	24.14	10.34	25.86	39.66	100	
Education manager (%)						0.004
Only practical agricultural experience	31.23	26.58	23.59	18.6	100	
Basic agricultural training	35.00	19.29	20.36	25.36	100	

Full agricultural training	24.43	21.37	27.74	26.46	100

Source: the authors

The performance in terms of sustainability indicators also varies according to the quartiles (Figure 4).

Figure 4. Comparison of means (standardized variables) of number of contacts of advisory service, and farm performance indicators, by quartiles of advisory service contacts



Source: the authors

The Kruskal-Wallis test was conducted to determine if sustainability indicators means are different between the four quartiles. Results from those tests are described in this section and shown in Appendix A.

The first quartile has a larger proportion of cattle and sheep farms, as well as larger proportions of farms in Germany, Finland and Ireland. The group has a larger *Share of permanent grass intensively managed*, the lowest *Share of potential EFA area on farms with arable area* and the lowest *Farm Gate N-Balance.* This group uses the lowest *Number of sources of information*, has the lowest *Working hours per week of manager* and the lowest *Social Diversification Index* among the 4 quartiles. This group has also the lowest *Gross farm income* and *Total labour in AWU*. It also has the highest *Age of machinery*, lowest percentage of farms adopting *Farm diversification* and *Farm innovation.*

The second quartile, where a larger presence of permanent crop farms is seen, has a larger *Share of potential EFA area on farms with arable area* and a higher *Farm Gate N-Balance* than quartile 1. This group uses a larger *Number of sources of information* and larger *Working hours per week of manager* and *Social Diversification Index* than quartile 1 but lower than the other groups. The *Gross farm income* and *Total Labour in AWU* is higher than quartile 1 but lower than the other groups.

Quartile 3 has a larger presence of field crops and partnerships; it has the highest *Water consumption /kg of product* and the lowest *Nitrogen use efficiency (NUE)* among the four quartiles. Following the

trend, this group has a higher *Number of sources of information*, *Working hours per week of manager* and *Social Diversification Index* than quartiles 1 and 2 but lower than the fourth quartile.

Finally, the fourth quartile has the lowest *Percentage of farm UAA with nitrate risk* and the lowest *Water consumption /kg of product* among the 4 quartiles. It has also the higher *Crop species diversity*, the highest *Share of potential EFA area on farms with arable area* and the highest *Farm Gate N-Balance*. It has also the highest *Number of sources of information*, *Working hours per week of manager* and *Social Diversification Index*. This group has also the largest *Gross farm income*, *Total labour in AWU* and the largest proportion of farms that use *Farm diversification*, and *Farm innovation*. The *Age of machinery* is the lowest of the groups as well as the share of farms that practice *Credit avoidance*.

From quartile 1 to quartile 4 we can observe an increase in economic size, farm area as well as an increase in the share of fully agricultural trained farm managers. No significant differences among the quartiles were identified in *age*, *gender*, *Percentage of farm UAA associated with erosion risk*, *Percentage of farm area with erosion mitigation*, *GHG emissions at farm level*, *Rural development subsidies* and *Total support for rural development* (Appendix A). Thus, this analysis indicates that from the first to the fourth quartile, selected, but not all, performance indicators change stepwise according to the number of advisory contacts. This can lead to the conclusion that advisory contacts are related to different performance of farms.

3.3.2 Cluster analysis

We have clustered the sample according to five indicators: *Total number of contacts with advisory services*, *GHG emissions at farm level*, *Farm Gate N balance, Farm net value added/AWU* and *Total labour in AWU.* According to this clustering, the sample can be divided in three groups which are quite distinct in number. Their profile is described in Table 9.

Cluster 1 has on average 27.10 advice contacts per year, from which 8.03 are related with crop production. Cluster 2 has on average 69.13 contacts per year, from which 41.06 are related with production issues. Finally cluster 3 has 17.47 contacts, from which 9.22 are production related contacts (Table 9).

Cluster 1 has a larger UAA, a larger proportion of farms of the biggest economic size and a larger share of companies. Cluster 2 has a higher share of economic larger farms and more presence of farm partnerships. Cluster 3 is formed also mostly by family farms with smaller economic size (Table 9).

Table 9. Profile of farms by clusters

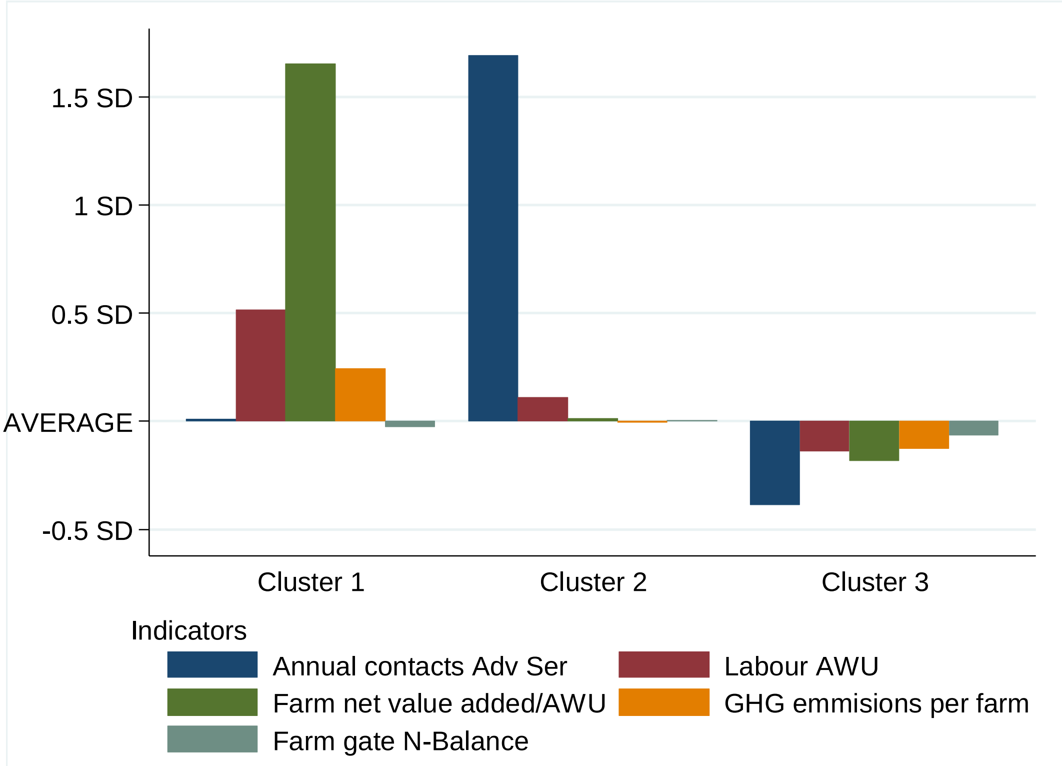
	Cluster1 N=86	**Cluster2 N=110**	**Cluster3 N=474**	**All farms* N=670**	Test of equality of means/proportions
Number of advisory contacts per year per holding (mean)	**27.10**	**69.13**	**17.14**	26.95	0.0001
Number of contacts with advisory service related to accountancy, management or investments (mean)	8.30	23.66	7.13	9.99	0.0001
Number of contacts with advisory service related to crop and animal production and animal products (mean)	16.94	41.06	9.22	15.44	0.0001
Number of providers used per farm (mean)	2.81	3.00	2.08	2.33	0.0001
Utilized Agricultural Area in ha (mean)	261.54	121.56	49.94	88.86	0.0001
Economic Size Group (%)					0.000
2,000 - < 8,000 EUR	0	0	100	100	
8,000 - <25,000 EUR	1.85	3.70	94.44	100	
25,000 - <50,000 EUR	0.81	9.76	89.43	100	
50,000 - <100,000 EUR	4.55	19.70	75.76	100	
100,000 - <500,000 EUR	17.92	19.81	62.26	100	
>= 500,000 EUR	49.37	32.91	17.72	100	
Type of ownership (%)					0.000
Family farms	7.49	14.79	77.72	100	
Partnerships	28.85	21.15	50.00	100	
Commercial farms	50.00	28.13	21.88	100	
Education manager (%)					0.016
Only practical agricultural experience	8.51	11.06	80.43	100	
Basic agricultural training	11.02	15.75	73.23	100	
Full agricultural training	13.69	19.77	66.54	100	

*The total sample was reduced due to the missing values of the clustering variables.

Source: the authors

There are significant differences in the performance indicators across clusters (Figure 5).

Figure 5. Comparison of means (standardized variables) of number of contacts of advisory service, and farm performance indicators, by identified clusters



Source: the authors

Similarly to the previous section, the Kruskal-Wallis test conducted shows that there are differences in the means of sustainability indicators across clusters. Results from those tests are described in this section and shown in Appendix B.

Cluster 1 includes 12% of the farms. This group of farms has the highest average *GHG emission per farm,* the lowest *Water consumption /kg of product* and the highest *Crop species diversity* among all clusters. It has a higher *Number of sources of information,* and larger *Working hours per week of manager* than cluster 3. It also has the highest *Social diversification index* and the highest perception *satisfaction with their quality of life.* The farms in this cluster have the highest values for *Gross farm income* and *Farm net value added/AWU*. Farms in this cluster have also the lowest *Age of machinery* and also the lowest adoption of *Credit avoidance* and *Farm innovation*.

Cluster 2 includes 16% of the farms. Overall, it has the most contacts with advisory services and the *GHG emissions* are larger than the average of Cluster 3. It has also the highest *Farm Gate N-Balance*, the lowest *NUE* and the largest *share of potential for EFA*. This group uses the highest *Number of sources of information* and also on average the managers work more hours per week than the other clusters. These farms have lower *Social Diversification Index* than cluster 1. With regard to the economic indicators, this cluster has a lower *Gross farm income* and *Farm net value added/AWU* and *Total labour in AWU* of cluster 1 but larger than cluster 3. Compared to the other groups, a larger share of farms has adopted innovation and farm diversification practices.

Cluster 3 includes 70% of the farms. It is composed by farms with the highest *Percentage of farm UAA with nitrate risk,* low *GHG emissions, at farm level*, and the highest *Water consumption /kg of product.* Farms in this group also have on average the lowest *Crop species diversity index,* the lowest *Farm Gate N-Balance* and the lowest *Use of pesticides* among the three clusters. This group uses the lowest *Number of sources of information*, the lowest *Working hours per week of manager,* the lowest perceived *Satisfaction with quality of life* and the lowest *Social Diversification Index*. This cluster also has a significant lowest *Gross farm income*, *Farm net value added/AWU* and *Total labour in AWU* compared to

the other clusters. It has also the highest *Age of machinery* and the largest share of farms that practice *Credit avoidance*.

The cluster analysis helps to differentiate the somehow simpler picture of the quartile analysis. It shows that the economically high performing farms in Cluster 1 come along with an average of advisory contacts. On the other hand, the farms with a very high number of advisory contacts do not show an unambiguous positive portray but reveal a mixed picture: they are labour intensive, have a high farm gate N-balance and lowest NUE. Thus, this cluster analysis underlines the challenge of assessing farm-level sustainability through a selection of indicators across farm types.

4 CONCLUSIONS

In the current study, the use of advisory services and the linkages with farm-level economic, environmental and social indicators are analyzed. In this part, we develop conclusions with regard to the objectives: the use of advisory services and linkages to sustainability (4.1) and reflections on the applied methods (4.2).

4.1 The use of advisory services and links with sustainability

1. In all farms of the FLINT sample, throughout all types and countries, a frequent use of advisory services could be observed. Even at country level, the average number of contacts is hardly less than one per month (Germany, Ireland) which can be interpreted as a continuous type of contact. With regard to the advice's contents, most farms across all countries make use of both, production and accountancy and management related advice. Nevertheless, a dominance of production related advice events can be observed, while accountancy and management related advice figured on the second place in almost all countries. The absolute figure of advice contacts is however unequally distributed: a quarter of the sample has on average only 6 contacts per year, half of the sample between 15 and 24 and a quarter has on average 59 advisory contacts. The number of contacts is linked with the type of farm, size of the farm, type of ownership and education of the farm manager.
2. While generally well trained farm managers significantly make more frequent use of advice, age and sex of farm managers seem to be of no matter in this regard. On the other hand, it is the 'granivores' farming system which clearly sticks out of all others in terms of reporting advisory contacts, followed by horticulture. Both systems range as relatively 'intensive' in terms of external inputs which may be a determinant for the more frequent advisory contacts. From these findings, we conclude that both, selected farm managers' and farming systems' characteristics play a determining role for the use of advisory services.
3. In all countries, there was more than one type of service provider present, and accordingly, most farm managers make use of more than one advisory service. Interestingly, there is a certain country-specific variability of the farmers' choices of preferred service providers. However, this information has to be embedded in the national institutional contexts and hence, there is a need to explore the respective AKIS (agricultural knowledge and information system) and herein, the availability of advisory services for the respective farm types in a certain region. Further studies whether and how these choices are related to the configuration of the national AKIS are required to give more evidence on 'best fit' of advisory service providers' constellations (Birner et al. 2009; Knierim et al. 2015).
4. Economic indicators can be linked to advisory services in a straightforward way as advice is considered to be constitutive for farm development and farm level innovations (Rogers 2003). Environmental and social sustainability indicators are more complex to be operationalized in their linkages to advisory services. Hence, the FLINT hypotheses for linkages between advisory services and social and environmental indicators were not specific enough for an in-depth discussion of the statistical findings. Results suggest a positive link between the number of advisory contacts and the degree of farm diversification, innovation adoption and information sources used by the farm manager. There is also a significant correlation between the number of advisory contacts and both gross farm income and labor. Also, the results indicate that with the increase of farm size (area and economic farm size) there is an increase of demand for advisory services. Results do not suggest a link between the number of advisory contacts and subsidies for rural development including advisory services. This suggests that there is no easy evaluation of rural policy impact at farm level with the help of the advisory service indicator number of contacts. Further and qualitative research is needed.

4.2 Reflections on the applied methods of data analysis

1. The applied methods were appropriate to get an overview of advisory services' use according to farm types in the various countries: most clearly, they play a broadly acknowledged role for both management and production issues. So far, advisory services are not yet included in the FADN data. As a first result, we conclude that in order to further investigate the role(s) and impacts of advisory services for farm-level sustainability more systematically, there are good reasons to include advisory service variables in a future FADN data set.

2. However, the applied analytical methods have shown limitations for revealing cause-effect relationships. To make these links clearer, there is a need to specify concepts for impacts of advisory services on farmers' decision making and behavior, to distinguish between farming practices and outcomes and to determine expected causality chains linked to advisory services. It would be necessary to identify these chains in form of hypotheses for all three dimensions of sustainability, with a priority for the environmental indicators.

3. Comparing the analysis of the two grouping methods (quartiles and cluster analysis) we can observe obvious differences from the two analyses' results: while the quartile analysis seems to suggest a linear relation between some indicators and increased advisory contact, this result is challenged by the cluster analysis. There, the economically most performing farms have only an average number of advisory contacts. Although we have to be careful with regard to our selection of indicators for sustainability, we can nevertheless conclude that both methods have their limitations. Here, a conceptual model explaining the multi-dimensions of sustainability and their performance as influenced by incorporating advice and implementing new knowledge could help to identify relevant indicators.

4. Beyond the presented analyses, the FLINT data set could be used to get further insights and identify possible causality links on: i) factors that influence the likelihood of using advisory services (e.g. via a regression analysis); ii) effects of subsidies on the use of advisory services; iii) effects of advisory services on farm practices and selected sustainability outcomes for different farm subgroups; iv) differences in advisory providers' constellations and types of advice and their effects on sustainability.

5. Finally, as a certain disclaimer, we have to recall that the indicator 'number of contacts' does not say anything about the duration, the intensity, and the relationship – in short: the quality of the advice services provided – which is considered a key factor for a successful advisory work. Hence, the degree to which 'number of contacts' can be used as a quantified proxy indicator for the success of advisory work in general needs further research. Specific studies exploring these aspects and looking into causalities should be undertaken. Collecting and analyzing the corresponding indicators over a range of years will give a clear view of the needs for advisory services and also will support the evaluation of the relevant measures.

6. To sum up, the collection of related variables has a good potential to help policy makers and policy evaluators to systematize and to evaluate the contribution of advisory services to the success of CAP policies according to the needs of farmers differentiated in farm-level subgroups.

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APPENDIX

Appendix A. Comparison of sustainability indicators per quartiles of S_1_1

Indicators	Quartile 1			Quartile 2			Quartile 3			Quartile 4			All farms			Test of equality of means
	mean	N	sd	mean	N	sd	mean	N	sd	mean	N	sd	mean	N	**sd**	
E_1_1	27.84	228	62.03	12.71	176	141.35	18.76	200	87.05	-32.71	216	672.70	6.43	820	355.74	**0.0036**
E_10_4	0.33	289	0.24	0.33	229	0.22	0.30	246	0.21	0.28	255	0.22	0.31	1019	0.22	**0.0023**
E_11_1	34.30	72	37.07	38.55	42	34.96	25.69	35	32.71	24.56	34	26.13	31.82	183	34.13	0.2422
E_11_8	58.94	72	48.82	144.00	42	389.37	66.13	35	44.64	60.76	34	46.32	80.18	183	192.54	0.7972
E_14_1	200.95	184	333.45	264.10	152	433.50	392.69	162	1016.01	658.06	178	2657.30	381.46	676	1483.98	0.3329
E_16_1	74.63	211	331.73	71.57	189	259.59	110.49	216	402.07	53.58	227	171.70	77.46	843	303.52	**0.0074**
E_18_1	2.28	289	1.39	2.33	229	1.30	2.73	246	1.49	2.96	255	1.54	2.57	1019	1.46	**0.0001**
E_2_2	38.23	294	235.37	108.58	233	1274.40	121.20	250	885.78	309.24	256	2291.61	141.34	1033	1370.44	**0.0097**
E_4_1	0.0004	165	0.0011	0.0004	133	0.0006	0.0010	172	0.0072	0.0005	183	0.0010	0.0006	653	0.0038	**0.0144**
E_5_1	176.12	184	256.05	303.40	152	791.94	374.10	162	908.19	2525.01	178	18092.22	870.68	676	9336.62	**0.0001**
E_5_3	809.74	179	10599.05	10.63	150	16.20	9.82	160	8.42	11.50	176	11.84	225.77	665	5499.19	**0.0355**
S_1_4	2.84	280	1.48	3.02	216	1.66	3.35	237	1.59	3.95	239	2.01	3.28	972	1.74	**0.0001**
S_5_18	32.28	258	12.58	33.84	196	11.31	36.69	209	11.89	37.39	197	12.10	34.88	860	12.19	**0.0001**
S_6_2	6.79	292	2.07	6.19	231	2.26	6.09	248	2.16	6.06	256	2.21	6.31	1027	2.19	**0.0001**
S_6_4	7.18	288	1.96	6.76	228	2.26	6.90	239	2.09	6.94	251	1.97	6.96	1006	2.07	0.1145
S_6_6	5.59	288	2.20	5.62	229	2.34	6.01	248	2.40	6.42	252	2.35	5.91	1017	2.34	**0.0004**
S_7_2	2.63	294	2.31	2.68	233	2.50	3.03	250	2.70	3.27	256	2.51	2.90	1033	2.51	**0.0029**
SE623	728.48	294	3940.44	1354.15	233	8611.18	1183.99	250	8585.71	2015.16	256	11030.62	1298.71	1033	8315.82	0.5785
SE410	65519.50	294	104955.90	75053.46	233	118986.30	114283.10	250	246486.90	225415.00	256	672618.10	119097.00	1033	369896.40	**0.0001**
SE420	22324.21	294	54536.92	25266.51	233	58890.61	19174.04	250	114438.90	46912.33	256	515361.80	28318.96	1033	265574.20	0.3075
SE425	20883.54	294	30205.81	22614.48	233	45343.42	20545.36	250	41067.21	28757.67	256	43037.73	23143.50	1033	39960.21	0.4552
SE010	1.93	294	1.88	2.06	233	1.88	3.86	250	8.43	5.22	256	19.87	3.24	1033	10.88	**0.0001**
EI_6_1	15.77	289	7.46	13.60	225	6.64	13.91	246	7.68	13.12	251	6.65	14.17	1011	7.21	**0.0001**
EI_9_1	0.38	294	0.49	0.46	233	0.50	0.51	250	0.50	0.57	256	0.50	0.47	1033	0.50	**0.0013**
EI_9_4	0.45	294	0.50	0.48	233	0.50	0.43	250	0.50	0.38	256	0.49	0.43	1033	0.50	**0.2287**
EI_1_4	0.33	294	0.47	0.37	233	0.48	0.42	250	0.49	0.55	256	0.50	0.42	1033	0.49	**0.0001**
SE624	6928.64	294	16566.48	4988.85	233	13076.86	5667.28	250	16399.50	10397.63	256	42807.34	7045.53	1033	25263.61	0.3703

Source: the authors

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Appendix B. Comparison of sustainability indicators by clusters

Indicator	Cluster 1			Cluster 2			Cluster 3			All farms			Test of equality of means
	mean	N	sd	mean	N	sd	mean	N	sd	mean	N	sd	
E_1_1	27.19	62	61.48	12.22	94	59.31	27.79	355	68.84	24.85	511	66.48	**0.0192**
E_10_4	0.31	86	0.23	0.29	110	0.21	0.35	474	0.21	0.34	670	0.21	**0.0008**
E_11_1	27.09	8	32.85	18.83	8	14.36	26.95	76	31.41	26.26	92	30.29	0.9835
E_11_8	79.12	8	37.45	53.55	8	43.79	48.11	76	48.10	51.28	92	47.32	0.3233
E_14_1	734.77	86	1292.92	370.17	110	715.96	195.87	474	380.23	293.66	670	656.42	**0.0065**
E_16_1	4.48	58	12.88	52.36	95	195.41	113.40	383	382.20	90.79	536	335.35	**0.0004**
E_18_1	3.20	86	1.97	3.16	110	1.52	2.38	474	1.32	2.61	670	1.49	**0.0001**
E_2_2	178.65	86	1370.71	435.70	110	3325.16	25.17	474	135.74	112.27	670	1440.96	**0.0057**
E_4_1	0.0005	50	0.0007	0.0005	85	0.0012	0.0004	299	0.0009	0.0005	434	0.0010	**0.0071**
E_5_1	616.71	86	1071.40	884.47	110	4312.18	230.49	474	570.96	387.43	670	1863.02	**0.0001**
E_5_3	14.28	86	22.56	10.55	109	8.63	318.34	464	6583.39	227.75	659	5524.17	0.109
S_1_4	3.83	78	1.91	4.32	106	2.16	3.12	440	1.63	3.42	624	1.83	**0.0001**
S_5_18	37.63	48	15.12	42.87	82	12.51	36.08	405	14.26	37.26	535	14.27	**0.0001**
S_6_2	6.94	86	1.86	6.20	110	2.16	6.29	470	2.31	6.36	666	2.24	**0.0249**
S_6_4	7.79	78	1.29	6.89	108	2.03	6.80	459	2.24	6.93	645	2.14	**0.0011**
S_6_6	5.15	84	2.36	6.82	108	2.28	6.11	463	2.35	6.11	655	2.38	**0.0001**
S_7_2	3.85	86	3.08	3.08	110	2.30	2.26	474	2.28	2.60	670	2.46	**0.0001**
SE623	1165.86	86	7762.07	1498.77	110	9845.20	1158.50	474	8572.47	1215.31	670	8684.50	0.478
SE410	586584.20	86	1094311.00	158888.00	110	230245.50	46068.01	474	63523.22	133970.40	670	442213.30	**0.0001**
SE420	221775.70	86	521196.50	39717.98	110	105811.80	15503.56	474	45191.12	45955.79	670	205959.70	**0.0001**
SE425	89673.95	86	46060.17	23733.41	110	28253.96	15724.92	474	18665.77	26531.71	670	35249.23	**0.0001**
SE010	8.81	86	15.10	4.42	110	6.17	1.76	474	1.55	3.10	670	6.53	**0.0001**
EI_6_1	12.42	85	4.53	13.03	110	6.28	15.23	462	7.61	14.50	657	7.15	**0.0007**
EI_9_1	0.43	86	0.50	0.64	110	0.48	0.51	474	0.50	0.52	670	0.50	**0.0379**
EI_9_4	0.22	86	0.42	0.44	110	0.50	0.51	474	0.50	0.46	670	0.50	**0.0001**
EI_1_4	0.38	86	0.49	0.61	110	0.49	0.40	474	0.49	0.43	670	0.50	**0.0017**
SE624	14040.86	86	40340.33	8432.86	110	28044.40	4759.44	474	13909.39	6553.89	670	21949.07	0.4615

Source: the authors