Assessing the Links between Advisory Services and the Sustainability of Farms

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Abstract: This research aims to explore the use of advisory services and their linkages to the economic, environmental and social performance of farms. Using a sample of 1096 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. 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.

Key words: advisory services, sustainability farm-level indicators

1. Introduction

Agricultural advisory services are seen as one of the most prominent instruments for farm innovation (Hoffmann et al. 2009; Labarthe 2009; Rivera and Sulaiman 2009) and therefore, a means of adaptation of agricultural production systems to the changing legal frameworks and the societal demands. In order to promote rural development and agricultural innovation, advisory services are part of the mechanisms 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; EC 1782/2003). Member states are encouraged and entitled to EU co-funding to set up 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.

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). The process is provided 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). Agricultural advisory service providers (AAS) are "*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). The concept is extended to the Agricultural Knowledge and Innovation Systems' (AKIS), where a broad range of actors can be identified and address knowledge infrastructures related to the sector or its specific branches (Knierim et al. 2015) and to

specifically focus communication and interaction among actors in agricultural innovation processes (EU SCAR 2012; EU SCAR 2013).

Despite their relevance, the knowledge about the effectiveness and the impact of extension remains fragmented and there is still an overall lack of data and research for evidence-based policy (Labarthe et al. 2014; SCAR 2016). This can be attributed to two reasons. On the one hand, there is the complexity of the influencing factors and contexts on the service relationship that makes standardized evaluations nearly impossible. Second, a huge diversity of organizational settings across the EU member states renders a cross-cutting analysis very challenging. This is confirmed by the evaluation of the FAS in 2009 (EC 1782/2003) (ADE 2009) and by the EU wide survey of the PRO AKIS project (www.proakis.eu).

In this frame, the assessments of effectiveness of extension services have shown mixed results and dependent on the context. According to the extension service curriculum, length of implementation, crop, region and farmer characteristics, a meta-analysis of 134 articles conducted by Waddington et al. (2014) found that advisory services increase knowledge, may lead to higher yields or net revenues and may have spill overs to non-participant neighbour farmers. Farmers receiving advisory services are better informed, and feel more secure about cross compliance (Knierim et al. 2011). 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). Faure et al. (2012) identify that challenges in advisory service research are mainly the accounting of interactions of several actors, to recognize the different orientations of advisory services and the relevance of new methods of extension (Faure et al. 2012).

The links of advisory services with sustainability of farms, as a multi-dimensional term with multiple and sometimes conflicting objectives has been less explored. In recent studies, advisory services are argued to contribute to more sustainable ways of production (Vasileiadis et al. 2017). This article aims to contribute to fill the gap on the research of advisory services and sustainability using harmonized variables for both sustainability and advisory services in different contexts and institutional settings. The objective is to explore the use of advisory services by European farmers and their linkages with farm-level economic, environmental and social performance. To reach that objective, two research questions are responded: *How advisory services are used and are correlated with a set of sustainability indicators? What is the profile of different users of advisory service according to their sustainability performance?* The article presents the methods used, the main findings on the use of the advisory services, linkages with sustainability indicators and the profile of advice-taking farms.

2. Methods and data

2.1 Description of the sample

The sample consists of 1096 farms part 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 sample includes accountancy data from FADN ('FADN data'), as well as additional data on economic, environmental and social sustainability of farms ('FLINT data') gathered in the framework of FLINT project. 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.

Table 1. Description of the sample

	Total	FR	DE	EL	ES	FI	HU	IE	NL	PL
Total number of farms	1099	280	52	124	128	49	102	63	155	146
Average utilised agricultural area (hectares)	106.1	107.3	179.3	18.25	84.1	97.2	416.2	52.8	53.5	36.8
Family farms (number)	764	119	43	124	97	47	77	63	48	146
Holdings under partnership ownership (number)	272	139	5	0	26	1	5	0	96	0
Average age manager* (years)	51.3	51.6	53.1	51.8	51.9	46.4	54.4	55.5	50.14	49.6
Female managers* (number)	179	15	2	36	0	31	13	1	57	24
Managers* with only practical agricultural training (number)	441	18	6	46	179	26	26	62	35	43
Managers* with basic agricultural training (number)	365	159	22	6	5	37	37	0	61	38
Managers* with full agricultural training (number)	521	103	36	72	0	25	39	1	172	73

Source: the authors

*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.

2.3 Description of the variables

Farm-level advisory services was measured 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. 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 according to eight themes 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 'type of advice' was aggregated in three major categories: 'advice for production', 'advice for management/financial-related issues' and 'others'. Personal characteristics of the manager (gender, education grade and age) were calculated identifying the manager who reported the largest number of annual working hours on the farm. Table 1 and 2 include the definition of variables used.

Table 1. Variables used

Variable definition (units/categories)	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

*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

The correlation of advisory services and the three pillars of sustainability at farm level was explored. 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).

Table 2. Sustainability indicators at farm level

Indicator definition (units)	CODE
Environmental dimension	
Share of permanent grassland under intensive management (%)	E_1_1
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
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
Economic dimension	
Gross farm income (EUR)	SE410
Family farm income (EUR)	SE420
Farm net value added/AWU (EUR)	SE425
Total labour in AWU (AWU)	SE010
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 dimension	
Number of sources of information (number)	S_1_4
Number of persons participating in training events	S_2_5
Working hours per week of manager (hours)	S_5_18
Satisfaction with quality of life (scale from 0 to 10)	S_6_4
Social diversification index (number)	S_7_2

Source: the authors

2.4 Description of the analysis

The analysis of the data was made on three steps: (i) identification of outliers, (ii) descriptive analysis of advisory services and their linkages with sustainability indicators and (iii) cluster analysis. Thirteen farms which reported more than 160 contacts per farm per year (outliers) were not included in the analysis. 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) according to farm types. The cluster analysis was made using 5 standardized selected 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)* 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.

3. Results and discussion

3.1 Overview of advisory contacts and types of advice

From the total sample, only 36 farms report not receiving advisory services during the last year. 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 or financial issues. 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.

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).

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

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

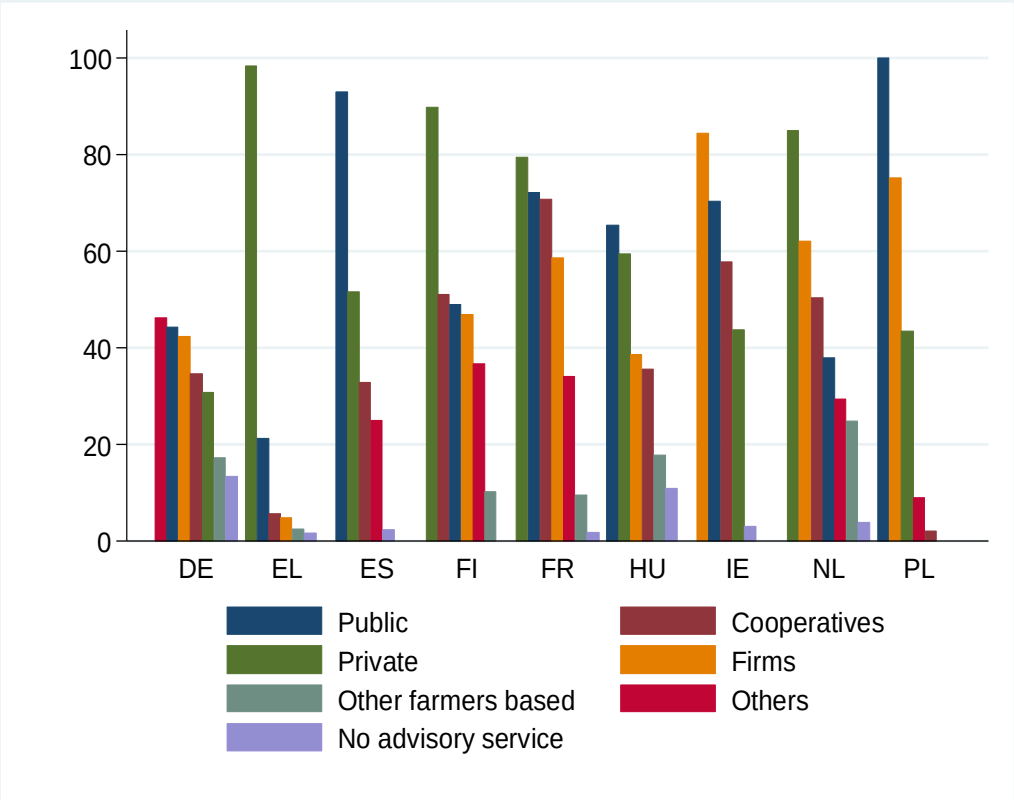
	Characteristics	Mean	SD	N	Test of equality of means
Sex of manager	Male	26.42	24.86	889	p=0.7814 Chi-squared 0.077 with 1 d.f.
	Female	26.52	26.98	85	
Education	Only practical agricultural experience	22.87	21.56	301	p=0.0065 Chi-squared 12.101 with 2 d.f.
	Basic agricultural training	26.78	26.99	280	
	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

3.2 Overview of providers of advisory services

The ‘organizational landscape’ of what type of service providers farm managers contact, differs across countries. On average, farms report contacting 2.5 types out of the six possible types of advisory service providers. 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 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 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. 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).

Figure 1. Percentages of farms having contacts with different advisory service providers, by country



Source: the authors

3.3 Linkages of advisory services and the three pillars of sustainability

Link to economic sustainability

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). 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

Social sustainability

The indicators considered for social sustainability can be grouped into those with a direct link to 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). 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) (Appendix A). 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 granivore farms this relation is significantly negative (r=-0.3151). 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). Farms with more advisory service contacts report more working hours per week (r=0.1811). Whether or not any cause-effect relations exist in all these cases cannot be determined on the basis of the existing data: a more differentiated analysis could give more clarity as the results differ when separating the sample by farm type.

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 an environmentally sensitive farming. Differences could be observed according to farm types. For the field crop farms, the more advisory contacts they report, 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 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.

3.4 Clustering different users of advisory services

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 profile is described in Table 6.

Table 6. 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. Results from those tests are described in this section and shown in Appendix B.

Cluster 1 includes 12% of the farms. Cluster 1 has a larger UAA, a larger proportion of farms of the biggest economic size and a larger share of companies than the other clusters. Farms in this cluster have on average 27.10 advice contacts per year, from which 8.03 are related with crop production. This group of farms has the highest average *GHG emission per farm*, the lowest *Water consumption /kg of product* 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 of *satisfaction with 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 percentage of adoption of *Credit avoidance* and *Farm innovation*.

Cluster 2 includes 16% of the farms, which on average have 69.13 advisory service contacts per year, from which 41.06 are related with production issues. Cluster 2 has a higher share of economic larger farms and more presence of farm partnerships. 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,* 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 innovations and farm diversification practices recently.

Cluster 3 includes 70% of the farms. Cluster 3 is formed also mostly by family farms with smaller economic size. This group has the fewer number of advisory service contacts per year (17.47) from which 9.22 are production related contacts. It is composed by farms with the lowest *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 largest share of farms that practice *Credit avoidance*.

The cluster analysis helps to differentiate the differences in sustainability performance among the farms. 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 reveal a mixed picture: they are labour intensive and have a high farm gate N-balance.

4. Conclusions

In the current study, the use of advisory services and the linkages with farm-level economic, environmental and social indicators are described. On average, throughout all types and countries, a use of advisory services could be observed with an unequally distributed frequency. Most farms across all countries make use of both, production and accountancy and management related advice. Farm managers' and farming systems' characteristics play a determining role for the use of advisory services. The number of contacts is linked with the type of farm, size of the farm, type of ownership and education of the farm manager. On the other hand, it is the intensive farming systems such as granivores and horticulture farming which clearly sticks out of all others in terms of reporting advisory contacts. In all countries, there was more than one type of

service provider present, and accordingly, most farm managers make use on average of more than two types advisory service providers. There is country-specific variability of the farmers' choices of preferred service providers embedded in the national institutional contexts and hence the respective AKIS.

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). 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. Environmental and social sustainability indicators are more complex to be operationalized in their linkages to advisory services.

Three clusters of farms were determined according to the similarities considering five key indicators of sustainability. There are significant differences between the clusters according to farm profile and the accomplishment of sustainability indicators. Clustering the farms according to their sustainability performance portrays the complex task of measuring sustainability and the linkages with advisory services: divergences in economic and environmental performance in several dimension does not allow for an easy classification for all the types of farming including in the sample. Causality analysis considering heterogeneity of the farms, factors influencing the choice of advisors providers and theories of change behind the advisory service programs are challenges for further research.

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7. Appendix

Appendix A. Correlation coefficients between the number of contacts of advisory services and sustainability indicators.

Indicator	Code	Correlation coefficient (n)	Type of farm with a significant correlation coefficient (r; n)
Economic indicators			
Gross farm income	SE410	0.2022*(1033)	Field crops(0.2457;254); Wine(0.4024;65); Other permanent crops(0.5283;94)
Family farm income	SE420	0.0196 (1033)	
Farm net value added / AWU	SE425	0.0203(1033)	
Total labour input	SE010	0.2910*(1033)	Field crops(0.2277;254); Other permanent crops(0.5732;94); Milk(0.3175;216); Other grazing livestock(0.3114;175)
Social indicators			
Number of sources of information	S_1_4	0.2306* (972)	Field crops(0.2665;252); Horticulture(0.5258;27); Other permanent crops(0.4015;71); Milk(0.2496;215); Mixed farms(0.2779;113)
Number of persons participating in training events	S_2_5	0.0503 (320)	Horticulture(0.5127;21); Granivores(-0.3151;42)
Working hours per week	S_5_18	0.1811* (860)	Field crops(0.1558;226); Other permanent crops(0.5516;92); Granivores(0.3823;59); Mixed farms(0.2815;107)
Satisfaction with quality of Life	S_6_4	-0.0405 (1006)	Other grazing livestock(-0.2530;134); Granivores(0.2544;78)
Social diversification index	S_7_2	0.1198* (1033)	Field crops(0.1764;254); Horticulture(0.5780;35)
Environmental indicators			
Share of permanent grassland under intensive management	E_1_1	-0.0978(820)	
GHG emissions. at farm level	E_14_1	0.0818 (676)	Horticulture(0.6397;33)
Direct blue water footprint (kg) water consumption /kg of product.	E_16_1	0.1258* (843)	
Share of potential EFA area on farms with arable area	E_2_2	0.1721*(1033)	
Pesticide Usage	E_4_1	0.0602(653)	
Farm Gate N-Balance	E_5_1	0.2407*(676)	Field crops(0.2928;159)

* p value<0.05
Source: the authors

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_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_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**
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**
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**

Source: the authors