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RESEARCH ARTICLE

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Innovation behaviour and the use of research and extension services in small-scale agricultural holdings

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Abstract

Farmers' views on research and extension services (RES) included in the Agricultural Knowledge and Innovation System are rarely investigated. This study analyses the relationship between key factors of innovation behaviour (market orientation, learning orientation, and innovation attitude) and the use of RES through structural equation modelling, focusing on small-scale agricultural holdings. Market orientation and learning orientation appear to be positively correlated, confirming that synergies between both factors provide a background for innovativeness. Learning orientation and farm-holders' education level, improve knowledge exchange and make the agriculture innovation process more inclusive. However, farmers' innovation attitude is not clearly correlated with the use of RES. Motivations about "the will to do innovations" are represented by a construct that does not appear to have a determinant effect as a mediator in farmer's decisions about using RES.

Additional key words: market orientation; learning orientation; innovation attitude; agricultural innovation system; farmer's innovativeness; structural equation model.

Abbreviations used: Agric Syst (Agricultural system); AKIS (Agricultural Knowledge and Innovation System); CAP (Common Agricultural Policy); CFA (Confirmatory Factor Analysis); EFA (Exploratory Factor Analysis); EU (European Union); EU-SCAR (Standing Committee on Agricultural Research - European Commission); IAT (Innovation Attitude); INE (Instituto Nacional de Estadística de España); INIA (National Institute for Agricultural and Food Research and Technology); KIS (Knowledge Intensive Services); LO (Learning Orientation); MO (Market Orientation); OCDE (Organization for non-economic Co-operation and Development); PRO-AKIS (Prospects for Farmers' Support: Advisory Services in European AKIS); R&D (Research and development); RDP (Rural Development Plans); RES (Research and Extension Services); SEM (Structural Equation Model); SMEs (Small and Medium enterprises).

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Introduction

In the context of the European Union (EU) strategies for 2020, farmers need timely access to knowledge and information, as well as training and education (EC, 2014). This must be facilitated by policy programs where agricultural research and extension services play a key role. The European Commission, with the Horizon H2020 and the new Rural Development Plans (RDP), is currently promoting crosscutting tools such as the Farm Advisory System and the European Innovation Partnerships (PRO-AKIS, 2012). This study proposes an empirical analysis of innovative small-scale agricultural holdings to assess the use of Research and Extension Services (RES) at the local level.

Understanding what motivates farmers to use RES is our core objective, with the key question on whether or not the most innovative farmers are those who make more use of RES. We consider that small-scale agricultural holders in Southern European regions abil-

ity to adopt the instruments of knowledge transfer supplied by available RES are related to cultural values such as market orientation, learning orientation, and innovation attitude. In the context of the present paper, these variables are the expression of aptitudes, attitudes and values of that can influence farmer's behaviour and their willingness to use RES. To test this relationship, we designed a Structural Equation Model (SEM) to discuss the impact factor of different constructs to determine particular farmers' prospects in the usefulness of RES.

Innovation is considered the heart of value creation for small and medium enterprises, and a key strategy to improve productivity, sustainable resource use, and a resilient tool for rural development (OECD, 2006, 2013). In this context, Knowledge Intensive Services (KIS) are drivers for knowledge transfer to small firms (García-Quevedo *et al*., 2013). The intermediation in the agriculture knowledge infrastructure (R&D and KIS) is a highly valuable process (Klerkx & Leeuwis, 2008). KIS describe an interactive relationship between suppliers and users, and their role is crucial for creating and disseminating new products, processes, and services, which are essential for knowledge sharing (Mas-Verdú, 2007). Ton *et al*. (2015) describe alternative pathways to encourage smallholders to initiate creative practices through a co-evolutionary process that combines economic, institutional, social, and technological changes. This dynamic process prompted us to examine the extent to which innovative farmers interact with RES.

Globally, and in individual nations, many have benefited from productivity growth in agriculture, enabled by technological and organizational changes resulting from public and private investments in agricultural R&D (Alston, 2010). While European farmers can theoretically benefit from international research spillovers, empirical evidence shows that domestic R&D effects are more significant than those from foreign sources (Alfranca, 2005). According to Jacobs *et al*. (2002), the Total Factor Productivity elasticity of domestic R&D is 37%, whereas that of foreign R&D stands at 3%. Compared to other sectors, technology transfers from science to farming practice slowly, with a strong reliance on public R&D policy, which is less oriented to applied research and innovation. Particularly because of this low application of research, recent EU policy measures have increasingly focused on the innovation potential of the agri-food sector (European Parliament, 2014). The Common Agricultural Policy (CAP) recently acknowledged this need and has recently promoted reforms to enhance market orientation and innovation in agricultural holdings (Agrosynergie, 2013). Agricultural extension and research policy are important steps to facilitate innovation in food production, for which a good understanding of farmers' and prospects' innovation behaviour is essential for improving the effectiveness of public and private investments in agricultural RES (Läpple *et al*., 2015).

RES can be considered a part of the AKIS. Previous scholars classified agri-food as a low R&D intensive sector (Capitanio *et al*., 2009), which appears to be true in Spain (García-Martinez & Briz, 2000). In the Valencia region, where our study is located, agriculture shows relatively low R&D intensities compared to other sectors (Alba *et al*., 2012; García Álvarez-Coque *et al*., 2014). Small-scale agricultural holdings are vital elements of the agricultural system, so policies must be evaluate based on an assessment of how agricultural RES perform in rural areas (Klerkx *et al*., 2012; Isaksen & Nilsson, 2013; Esparcia, 2014). We tested the extent to which farmers are motivated to use RES by innovative attitude and by other structural or contextual variables.

Material and methods

Conceptual framework and hypotheses

The first step in understanding how RES enhances the AKIS is to determine the individual farmer's motivators for innovation. Our framework represents farmers' innovation behaviour profile as three components: market orientation (MO), learning orientation (LO), and innovation attitude (IAT). MO and LO can be considered antecedents of IAT (Keskin, 2006; Micheels & Gow, 2014) and, according to our framework, all shape farmers' willingness to consult RES.

Researchers have studied MO extensively since the 1990s as a key strategic factor for the innovation process. Narver & Slater (1990) observed MO as a cultural variable in its focus on customers and competitors. Kohli & Jaworski (1990) characterized MO as a behavioural process determining the firm's ability to generate and disseminate market information. Recent research observes that MO can be significantly enhanced by an entrepreneurial ecosystem and the institutional context (Hamed *et al*., 2012).

We hypothesize that farmers' MO acts as an antecedent of actual innovation behaviour (Hurley & Hult, 1998; Mavondo *et al*., 2005), in line with the idea that responding to market conditions involves doing something new or different (Kohli & Jaworski, 1990). Baker & Sinkula (1999) argue that MO is an input for the innovation process. Grinstein (2008) suggest a moderate positive relationship between MO and IAT, referring that market-oriented firms perceive information about

customer's needs, which can lead to innovative consequences as doing something new or different in response to market conditions. According to Micheels & Gow (2014), innovative managers transform valuable market information into product and process innovation. Innovation processes, therefore, depend on a variety of interactions where potential barriers may appear. We can hypothesize that firms' concerns about market signals (MO) are correlated with attitudes toward changing products, processes, and services (IAT).

— H1: MO has a positive effect on IAT

LO refers to cultural and organizational activities that use knowledge to enhance competitive advantages (Calantone *et al*., 2002). LO influences firms' propensity to create and use knowledge, and affects an organization's degree of information use and active learning as one important internal resource (Cohen & Levinthal, 1990; Farrell, 1999; Chaston *et al*., 2001; Anderson & Bookock, 2002). However, it is a time-consuming process that requires commitment and managerial skills, what can represent a constraint for SME (Lin *et al*., 2008). Furthermore, learning in SMEs is reactive in the short term and might suggest an adaptive behaviour rather than innovativeness (Badger *et al*., 2001). Trice & Beyer (1991) assert that MO and LO are entrepreneurial attributes that are very closely associated with innovation activities and culture. Extensive research also suggests a positive relationship or interdependence between LO and MO (Day, 1994; Slater & Narver, 1995; Sinkula *et al*., 1997; Baker & Sinkula, 2002; Bell *et al*., 2002; Lin *et al*., 2008). Grinstein (2008) also suggest that firms with lower learning capabilities have an inflexible construction of MO, which involves that market oriented effort of those firms could be associated to imitation rather than innovation. Therefore we can test how MO and LO affect the IAT and how MO and LO are interconnected in SMEs:

— H2: LO has a positive effect on IAT
— H3: LO is positively correlated with MO

Innovativeness is a core determinant of organizational success and competitiveness (Calantone *et al*., 2002). It represents the ability of permanently create knowledge and ideas into new products, processes and systems. Literature about innovation in SMEs acknowledges the role of innovation as an important strategic tool to achieve competitive advantages (Diederen *et al*., 2003; Gellynck & Kuhne, 2008). In our research context, the question emerges on the extent that the AKIS favours technological, economic, and institutional changes in agriculture (Hall *et al*., 2003; Morriss *et al*., 2006; Spielman *et al*., 2008; Klerkx *et al*., 2010). One core role in the AKIS system is the one played by RES, which includes both disseminating new techniques and alternative company organisation (Leeuwis & Van de Ban, 2004). This role requires a combination of local and specialized knowledge, and the support of extensive networks that can be integrated into the RES (Labarthe *et al*., 2013). RES are relevant to combine new knowledge with existing knowledge in new ways (Nielsen *et al*., 2008). Birner *et al*. (2009) consider the advisory and extension services 'as the entire set of organizations that will enable the farmers to co-produce farm-level solutions by establishing services relationships with advisers so as to produce knowledge and enhance skills'.

In this work, we evaluate the relationship between farmers' innovativeness behaviour and their use of extension services. Avermaete *et al*. (2004) justifies the RES by stressing that investments for R&D activities are rare for small firms in food industry.

As RES appears to be an available source for knowledge dissemination, the question arises as to whether these services are in fact useful for innovative farmers (PRO-AKIS, 2012). The RES institutional setting may not be effective in a context where knowledge gathering is part of an informal web or network of practice (Oreszcyn *et al*., 2010). Innovative farmers may have alternative ways to share knowledge beyond the RES, as it happens with those engaged in cooperatives (Fearne *et al*., 2013). On the other hand, we are interested in the cultural characteristics that motivate farmers to get advice from RES. Are MO and LO key drivers of the connection between farmers and RES? Is the impact of MO and LO on the use of RES direct, or is there a mediating effect through IAT? RES may respond to farmers' expectations for market information (MO) and learning about new techniques (LO), but not necessarily with developing innovation opportunities. We therefore propose:

— H4: IAT has a positive impact on RES
— H5(a): IAT mediates the positive relationship between MO and RES
— H5(b): IAT mediates the positive relationship between LO and RES

Figure 1 illustrates the research model as a path diagram that will be represented in a SEM that includes control variables such as age, education level, and farm size.

In order to test the previously established relations we proceed to estimate a Structural Equation Model by following the steps depicted in Figure 2. Firstly, we constructed a survey launched to a sample of farmers

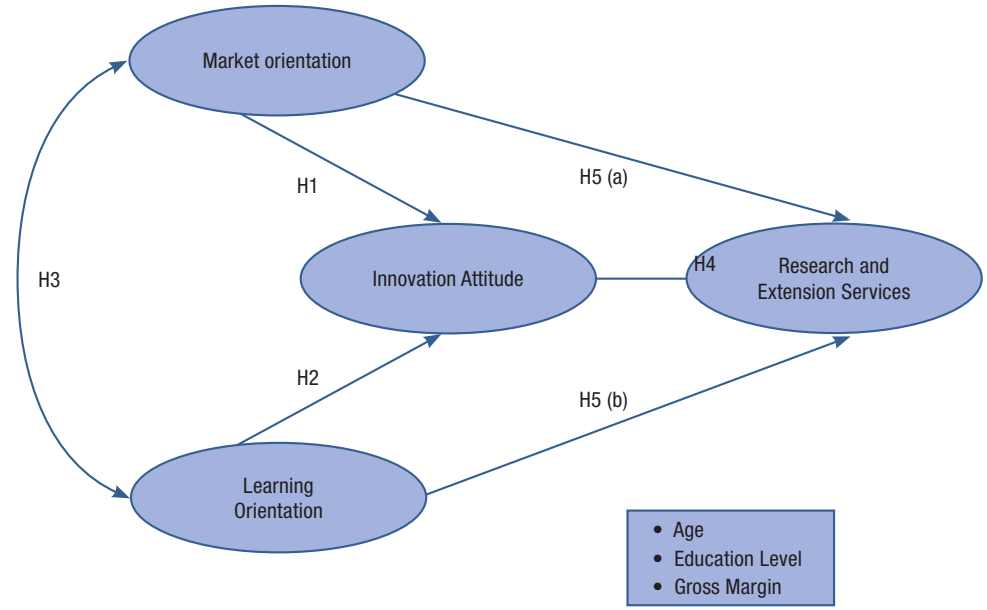

Figure 1. Path diagram and hypothesized relationships.

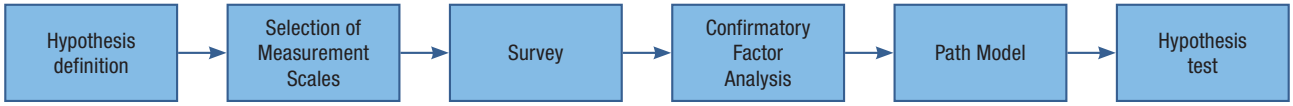

Figure 2. Executing processes of structural equation model.

in the Valencia region, where they answered to questions based on measurement scales of MO, LO, IAT and RES, as latent factors. Secondly, we examined how specific items relate to latent factors through a Confirmatory Factor Analysis. Thirdly, we estimated a path model to test the defined hypothesis. Finally we evaluated the mediating role of IAT in the relation between MO and LO and the use of RES.

Survey characteristics

The survey method assessed parameters related to enterprise managers' organizational behaviour, in this case, farmers. The questionnaire, summarized in Table 1, is designed to contain measurement scales based on previous studies to relate a series of variables or constructs.

For MO, we adopted a 6-item scale from Narver & Slater's (1990) work where in three scales focus on quality, competitors, and customer service. LO was measured on a 6-item scale developed by Johnson *et al*. (1997), Hult (1998), and Calantone *et al*. (2002), following the farmers' attitudes to receiving information from media and fairs, and their ability to analyse new techniques from a critical point of view. IAT was measured on a 6-item scale from previous research by Venkatesh & Davis (2000), and Sophonthummapharn (2009). IAT reflects farmers' willingness to emulate their innovation context (IAT2, IAT3), their motivation to change (IAT1, IAT4), or their expectations of better entrepreneurial performance (IAT5, IAT6).

As for RES, the scale identifies the main type of KIS supplied to farmers, and was adapted from previous work by Segarra & Arauzo (2008) and Schwartz & Hornych (2010). RES use refers to the farmers' willingness to seek advice from universities and research institutions (RES2), to take part in R&D projects (RES4), and to seek advice from local public extension offices (RES5).

We conducted a pilot study on a sample of 30 stakeholders, who provided a feedback about the questions' readability while maintaining and ensuring the content validity of constructs. We asked respondents to provide answers to survey questions on a seven-point Likert scale (1 = strongly disagree; 7 = strongly agree).

For control variables, we adopted two variables related to human capital and one related to farm structure. In terms of human capital, recent research into the antecedents of innovativeness reveals that age heterogeneity and education, play a significant role in SMEs (Gellynk *et al*., 2006; Baron & Tang, 2011; Turan & Ascigil, 2014). As SMEs are crucial agents of the rural economies (Avermaete *et al*., 2004; Baregheh *et al*., 2012), we consider the farm size as a control variable for our model. We focused on farm size in terms of

Table 1. Select sources of the measurement scales RES, IAT, LO and MO.

Construct category	Authors	Concept definitions
Research and Extension Services (RES)	Segarra & Arauzo, 2008 Schwartz & Hornych, 2010	The administration facilitates farms to innovate. I usually take advice from research centres and universities. The Common Agricultural Policy (CAP) helps to facilitate innovation. I take part in projects of research and innovation endorsed by public or private entities. I consult agricultural county offices to apply the best technics. I receive technical advice from my suppliers. I receive technical advice from cooperatives. I receive technical advice from professional organizations.
Innovation Attitude (IAT)	Harrison *et al.*, 1997 Venkatesh & Davis, 2000 Sophonthummapharn, 2009	Adopting innovation is a useful decision. I value people that innovate. The people who are important for me believe that I should innovate. I am motivated to innovate. Innovations improve the results of my farm. Innovation is worth.
Learning Orientation (LO)	Johnson *et al.*, 1997 Hult, 1998 Calantone *et al.*, 2002	I like reading magazines or watch media about new crops or methods that I could introduce. I enjoy attending fairs, courses, or seminars to learn new ideas. My employees and family members believe learning is important. I share experiences with other farmers. When a new technique/product does not yield results, I analyse the causes of the failure. I feel partly responsible for failures in my farm.
Market Orientation (MO)	Narver & Slater, 1990	I follow the quality guidelines I receive from clients. I search for new clients every year. Customers guide me on which crop varieties to grow. My interest in quality grants me advantages over other holdings. My interest in offering cheaper products grants me advantages over other holdings. Customer satisfaction is the main goal of my holding.

total gross margin results (Rama & Alfranca, 2003), which also refers to the hypothesis that available resources affect managers' decisions (Langemeier & Jones, 2000; Micheels & Gow, 2014). Recent empirical evidence suggests a positive relationship between firm size and the probability to innovate through improved access to human and financial resources and profit persistence (Laforet, 2008; Karantininis *et al*., 2010). Another characteristic of SMEs refers to their flexibility and interpersonal communication, which also involves innovation returns (Tsai *et al*., 2005).

Description of respondents

We collected the data for this research through a survey of farmers designed for the Agrinnova Project[1]. We evaluated our proposed model using a sample of farmers in the Valencian Community (VC) region. The region counts 119,659 agricultural holdings according to the last agricultural census (INE, 2009), with a strong presence of citrus, fruit, and vineyards, and a significant presence of poultry and pork production. Most farms are integrated in the market. Most are small-scale holdings, with 28.4% of these with less than 1 hectare, and only 4.1% with over 20 hectares. Given the intensive characteristics of the crops, the survey asked respondents to classify their farms according to gross margin classes to standardize farm size measurements across differing agricultural products.

The survey was mailed to a random sample of farm holders across the Valencia region and was supported by an agricultural research institution, IVIFA

[1] Project funded by the Ministry of Economy and Competitiveness (Spain) AGL2012-39793-C03

(Fundació Institut Valencià d'Investigació i Formació Agroambiental, http://www.ivifa.es), which has close connections to farming organizations in the region. Having a partner that mediated between the researchers and respondents assisted in developing the fieldwork and improving the potential response rate[2]. Our target group was agricultural holders with a cultivated area of 1 hectare or larger, though we did accept a few farms with a smaller total area in the case of livestock. Data were collected from May to December of 2012, and we obtained 253 usable surveys (40.8% response rate). This sample size is acceptable for SEM (Hoelter, 1983; Garver & Mentzer, 1999; Sivo *et al*., 2006), wherein a size above 200 is sufficient to provide statistical effectiveness for data analysis.

Table 2 presents the farm holder profiles from the final sample. The average age was 48 years, 51% of respondents have secondary or higher education, and gross margin is lower than €20,000 in 66% of the surveyed holdings.

As far as smallholders' perspectives, there is little previous work in the literature analysing the causality relationships between our construct categories (Table 1). If we consider all specific items covered by constructs, there are differences in the frequencies observed in the sample (Fig. 3). We see that a significant group of the surveyed farmers attach a positive evaluation to variables related to quality products, knowledge sharing and motivation to innovate, while the trend is opposite for related variables to their relation with the public administration or to their participation in research and innovation projects. It is outstanding that a substantial percentage of farmers do not attach significance to the RES' advice. The question is relevant when we later show that IAT and RES use show a weak correlation.

Table 2. Respondents' characteristics (n=253).

Variables	Mean	SD
Age	48.43	11.52
Education level[(1)]		
No regulated education	21	
Basic Education	102	
Higher education	130	
Gross margin[(1)]		
Over 20,000 EUR	87	
5,000-20,000 EUR	130	
Below 5,000 EUR	36	

[(1)] Education level and gross margin are reported in absolute frequencies.

Estimation method

Since this study aims to confirm the causal relationship between farmers' innovation behaviour and the use of RES, we developed the SEM in two phases. The first implied a measurement model that examines how specific items relate to latent factors through a Confirmatory Factor Analysis (CFA). The second phase is a covariance structural analysis to examine the model depicted in the Figure 1. The structural equation model included CFA, parameter estimation, evaluation of model fit, and a re-specification of the model to examine the hypotheses were analysed using SPSS® Amos program (Byrne, 2010).

The items (26) within the constructs were treated through Exploratory Factor Analysis (EFA) to determinate the sample adequacy for each variable for our factors of interest. Initially MO, LO, and IAT contained six sub-factor each, and RES was composed of eight sub-factors (Table 1). A CFA model confirmed the correlation among MO, LO, IAT, and RES, however, a few items for each variable with low and non-acceptable (close to 0.0) factor loadings were removed as indicated by the CFA in accordance with the hypotheses of our theoretical framework. All other factor loadings were acceptable, which allow to estimating a measurement model prior to a structural model. Deleting these items did not show significant improve or impair reliability. The reliability tests to examine the internal consistency for all constructs in this study are indicated by the Cronbach's alpha. High reliability values (> 0.70) were obtained for MO, LO and IAT except for RES (α=0.61), although α-values of 0.60 can be accepted in the earlier phases of the research (Nunnally, 1978). In addition, in order to identify multicollinearity among variables, variance inflation factors (VIFs) for all variables were computed in SPSS. VIFs values for all variables did not exceed 10.0, which suggests no serious concern about multicollinearity (Hair *et al*., 2010). The first column in Table 3 shows the final items selected corresponding to the constructs considered in the SEM.

Results

The measurement model obtained from the CFA was estimated through Maximum Likelihood (ML), and the correlation matrix exhibits significant relationships between the constructs (Table 4**).** The specific indicators that determine the goodness of fit of the CFA model, chi-square (CMIN) = 128.114; degrees of free-

[2] A few responses contained missing items (<10%), so we used the imputation method to fill in missing data.

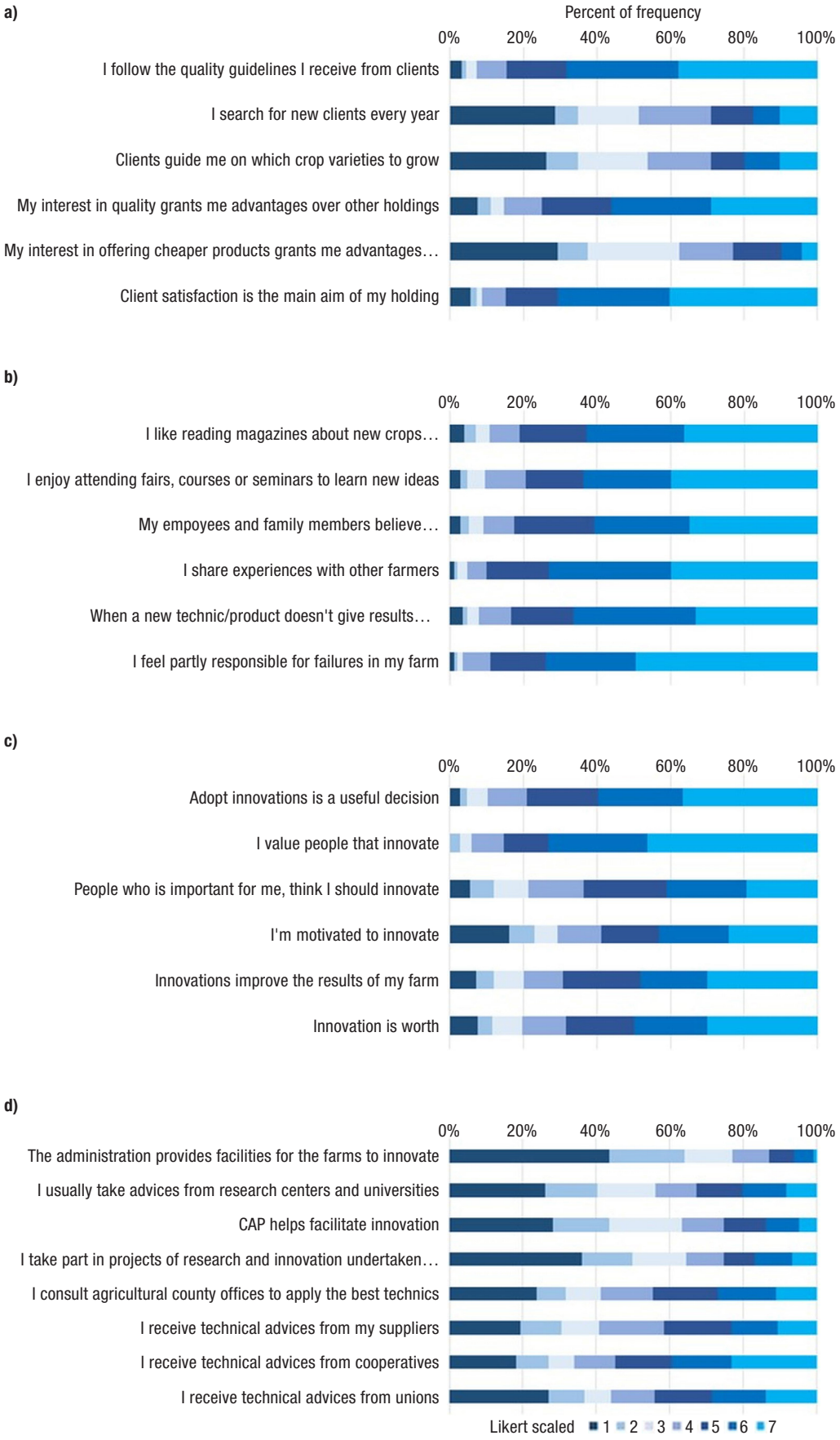

Figure 3. Frequencies for construct category: (a) market orientation (MO), (b) learning orientation (LO), (c) innovation attitude (IAT), and (d) Research and Extension Services (RES).

Table 3. Results from reliability and confirmatory factor analysis: MO-LO-IAT-RES.

Measurement scales and items	Cronbach's α[(1)]	Estimate[(2)]	Mean	SD	*p*
Research and Extension Services (RES)	0.61				
RES2. I usually take advice from research centres and universities		0.590	3.40	2.014	***
RES4. I take part in projects of research and innovation undertaken by public or private organisations.		0.568	2.98	2.003	***
RES5. I consult agricultural county offices to apply the best techniques.		0.588	3.86	2.085	***
Innovation attitude (IAT)	0.89				
IAT1. Adopting innovation is an useful decision		0.698	5.58	1.519	***
IAT2. I value people that innovate		0.667	5.96	1.292	***
IAT3. People who are important for me think I should innovate		0.677	4.86	1.726	***
IAT4. I am motivated to innovate		0.806	4.57	2.135	***
IAT5. Innovations improve the results of my farm		0.894	5.08	1.842	***
IAT6. Innovation is worth		0.847	5.10	1.844	***
Learning orientation (LO)	0.76				
LO1. I like reading magazines about new crops or methods that I could introduce		0.774	5.58	1.589	***
LO2. I enjoy attending fairs, courses, or seminars to learn new ideas		0.739	5.65	1.525	***
LO5. When a new technique/product does not yield results, I analyse causes of the failure		0.646	5.66	1.449	***
Market orientation (MO)	0.77				
MO1. I follow the quality guidelines I receive from customers		0.704	5.76	1.428	***
MO4. My interest in quality grants me advantages over other holdings		0.709	5.27	1.767	***
MO6. Customer satisfaction is the main goal of my holding		0.781	5.74	1.577	***

[(1)] Reliability: Cronbach's α. [(2)] Standardized regression weights: Estimate. *** Indicates that the correlation is significant at $p < 0.001$ level.

Table 4. Correlation matrix.

	Learning orientation	Market orientation	Research & Extension Services	Innovation attitude
Learning orientation	0.72			
Market orientation	0.65 (***)	0.73		
Research & Extension Services	0.53 (***)	0.48 (***)	0.58	
Innovation attitude	0.53 (***)	0.66 (***)	0.47 (***)	0.77

*** Indicates that the correlation is significant at $p < 0.001$ level.

dom (DF) = 81; probability level (p) = 0.001; CMIN/DF=1.582; comparative fit index (CFI) = 0.971; goodness of fit (GFI) = 0.937 and root mean square error of approximation (RMSEA) = 0.048, suggest that the dataset has a satisfactory fit to the model.

Once the CFA confirmed the model's suitability, we evaluated the causal theories set in the model through the interpretation of the structural path coefficients (Fig. 4). The SEM specifies and identifies a network of linear equations to connect endogenous latent variables and exogenous latent variables, where control variables are also considered.

The SEM estimation including ML produced the following goodness of fit indicators: CMIN = 161.091; DF = 121; p = 0.009; CMIN/DF = 1.331; CFI = 0.976; GFI = 0.933; RMSEA = 0.036. The co-variance relationship proposed in the SEM to test the hypotheses yielded a result for estimate correlation relationship, Coefficient (θ) = 0.756 (significant at $p < 0.001$) for the MO and LO, thus confirming H3. The remaining results obtained for the path analysis were divided between direct and indirect effects to examine the other hypotheses.

The results of the path model (Table 5) indicate a significant standardized regression coefficient and a positive relationship between MO and IAT (β=0.435; significant at $p < 0.001$), and the same holds for LO and IAT (β=0.295; p=0.028), suggesting that MO and LO are implicit characteristics of innovative farms. However, the effect of IAT on RES is non-significant

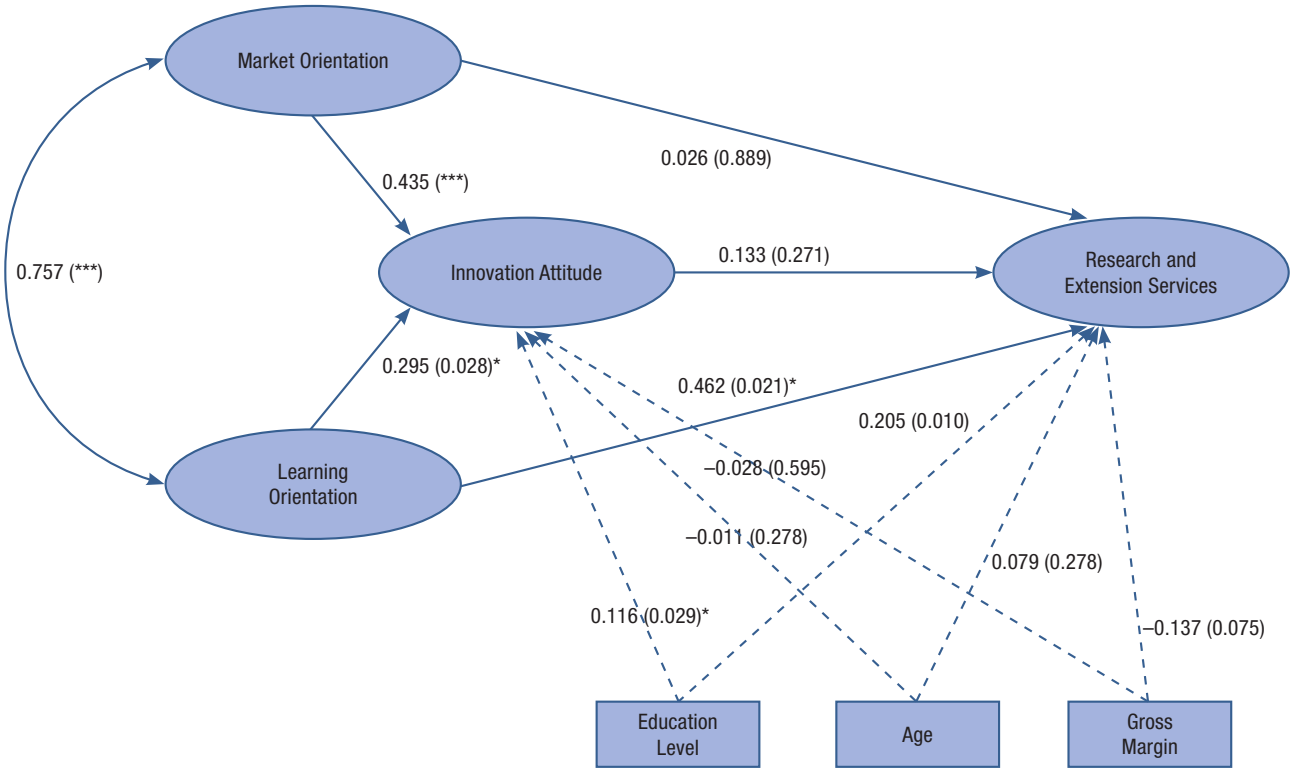

Figure 4. Results of the structural model. Dotted lines indicate the hypotheses regarding mediation effects.

Table 5. Estimated parameters in the path model.

Path			β[1]	*p*-value[2]
Market orientation	→	Innovation attitude	0.435	***
Market orientation	→	Research & Extension Services	0.026	0.889
Learning orientation	→	Innovation attitude	0.295	*
Learning orientation	→	Research & Extension Services	0.462	*
Innovation attitude	→	Research & Extension Services	0.133	0.271
Gross margin	→	Innovation attitude	-0.028	0.595
Gross margin	→	Research & Extension Services	-0.137	0.075
Education level	→	Innovation attitude	0.116	*
Education level	→	Research & Extension Services	0.205	*
Age	→	Innovation attitude	-0.011	0.828
Age	→	Research & Extension Services	0.079	0.278

[1] β= standardized regression weights parameter estimate. [2] *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

(β=0.133; p=0.271). Therefore, H1 and H2 are supported, but H4 is rejected. Additionally, we identified the effects of the control variables on IAT and RES. Education level appears to have significant and positive effects on both IAT and RES. The effects of farm holders' age and size on both constructs were not significant, and even the parameter estimates were negative in most cases.

Mediating role of IAT

Structural equation modelling is particularly effective when it tests mediating variables (Edelman *et al*., 2005; Rhee *et al.*, 2010; Chang & Hughes, 2012; Han *et al*., 2013). Once we rejected a significant relationship between IAT and the use of RES, the question remains about the possibility that IAT plays a mediating role in the relationship between entrepreneurial factors (MO and LO) and farmers' use of RES. To specify the mediating link, we investigated the direct and indirect effects of the independent variables (MO, LO) transmitted to the dependent variable (RES) through the mediating variable IAT (Baron & Kenny, 1986). Table 6 reports the results from first running the model without the mediator, which returns different results for the causal variables (MO and LO) in the outcome variable RES. The direct effect without the mediator is only

Table 6. Parameter estimates for the model path: direct and indirect effects (*p*-values in brackets).

Path	Direct effect without mediator	Direct effect with mediator	Indirect effect
Market orientation → Innovation attitude → Research & Extension Services	0.080 (0.666)	0.026 (0.889)	0.58 (0.238)
Learning orientation → Innovation attitude → Research & Extension Services	0.504 (0.011)	0.462 (0.021)	0.39 (0.139)

significant for the causal link from LO to RES. We then analysed the causal relationship in the path model including the mediating variable IAT, which returned different results for the effects of MO and LO on the RES. Contemporary analyses (Preacher & Hayes, 2004) consider the indirect effects measure obtained using bootstrapping to confirm whether the results from the direct effects indicate mediation. Significant indirect effects indicate that a significant part of the total effect of the independent variable on the dependent variable occurs because of the mediator. In our results, indirect effects are not significant in any case of causation between MO and LO on RES. With these results, following the established and identified types of mediation and non-mediation, we find no effect for MO. For the mediation between LO and RES, we confirmed direct relationships with and without mediators, but none indirect relationships. Therefore *H5(a)* and *H5(b)* were rejected.

To explain the failed direct and mediated relationship between IAT and the use of RES, we explored the relationships more specifically by running a linear regression that took the composite index of the RES construct as a dependent variable (RE_S), and the IAT scales as covariates. The first results show a positive relationship between IAT and RE_S, but with a low model fit (R^2 = 0.141). In the model, only the coefficient for IAT4 was significant ($\gamma = 0.23$, $p = 0.01$), while the rest did not significantly influence RE_S. IAT4 refers to only one category, '*I am motivated to innovate'*, which refers to one reason farmers interact with RES. This finding also supports the role of curiosity as an attribute of learning farmers' competences and the corresponding willingness to employ extension services.

Discussion

AKIS and RES

AKIS is 'a set of agricultural organizations and/or persons, and the links and interactions between them, engaged in the generation, transformation, transmission, storage, retrieval, integration, diffusion and utilization of knowledge and information, with the purpose of working synergistically to support decision making, problem solving and innovation in agriculture' (EU-SCAR, 2012). Nowadays, the AKIS is seen as a more complex network that constantly evolves, with a vision of knowledge, learning, and innovation (Klerkx & Leeuwis, 2008). Challenges in the agricultural sector include social issues and institutional design, which innovation aims to address in the new CAP. The last reform intended to promote smart, sustainable, and inclusive growth through knowledge transfer and innovation as crosscutting axes of rural development programs (European Parliament, 2014).

A major question remains about farmers' main socioeconomic attributes that influence their use of the AKIS, which contributes to the success of the new policy approaches. The new focus is on multi-driver innovation actors and continuous learning supported by the research and extension system (Dockès *et al*., 2011). A question emerges not only on the AKIS' ability to transfer technology, but also on the way farmers' innovation behaviour contributes to knowledge sharing (Läpple *et al*., 2015).

Our findings suggest that innovative farmers lack perceptions of usefulness of the AKIS system, which implies the need for improving its effectiveness at the EU and national levels. Furthermore, understanding the influence of the AKIS in a local context is essential for the innovation policy research and spillover process in SMEs (Audretsch *et al*., 2005; García-Quevedo *et al*., 2013). Rurality does not seem to prevent SMEs from participating in R&D projects, and geographical proximity to technological centres does not appear to provide a significant advantage for innovativeness (García Álvarez-Coque *et al*., 2013; Fearne *et al*., 2013). Farmers can be more or less innovative and use RES to varying degrees, and both characteristics can be observed together and separately.

The Spanish AKIS system is complex as the result of very diverse Agric Syst. The main central government agency is the National Institute for Agricultural and Food Research and Technology (INIA), though most RES are provided by universities and technological centres that play an important role in knowledge creation and research transfer followed by the agricultural county offices (*Oficinas comarcales*), created

through the agricultural extension services before the decentralization of the State in the 1980s. Some highlight the low-level connection between agricultural research and education institutions and end users' needs, as pointed out by the IMPRESA[3] consultation for Spain (Montero, 2014). Recent critics highlight that current regional extension services mostly manage and implement CAP grants rather than promote knowledge communities. The conceptual framework followed in this research considered the connection between innovativeness (IAT) and the farmers' use of RES, but also the link with other cultural variables (LO & MO) and structural factors (human capital characteristics and firm size).

Our results showed that IAT does not have a mediating effect between MO and LO, and RES. These results could indicate the limited role of the existing AKIS to accomplish the objectives of innovation policies promoted for primary producers. The causes of RES' failure to adapt to innovators' needs vary, starting from the simple explanations that innovators do not really need RES, the RES were not adequately designed to support innovation or that current institutional settings are not dynamic enough to respond to the concerns of the more creative farmers. Following previous work (Klerkx & Leeuwis, 2008; Pascucci & De-Magistris, 2012), we conclude that the RES in our study context would need to be re-evaluated to enhance their acceptance by the most innovative farmers, who are customers of innovation support services. A potential area for further research would be the assessment of firms' performance when farmers make use of knowledge services.

Positive role of MO and LO

Our findings support earlier studies (*e.g.,* Slater & Narver, 1995; Baker & Sinkula, 2002; Lin *et al*., 2008) noting the positive role of MO and LO as sound antecedents of innovation. The notion of causality of farmers' attitudes in our empirical research opens possibilities to investigate the acceptance of specific services supported by the current AKIS. Both constructs, MO and LO, have positive direct effects on farmers' innovativeness. Supporting the effectiveness to identify farmers' orientation aptitudes proposed by Läpple *et al*. (2015), these results are relevant in the context of rural and Agric Syst, dominated by small and medium-sized farms. A market and learning oriented culture appear to be positively related among our respondents', which confirms that synergies between both factors provide a background for technical and organizational change at the individual level in farm primary context.

We also focused on the contradictory causal relations between the use of RES and MO and LO, seen as entrepreneurial attributes, and the innovation attitude. All attitudes exist in our sample, but with varying causal effects to explain the use of RES. An entrepreneurial farmer does not necessarily mean to be an innovator, and an innovator does not necessarily appreciate RES, though the limitations of our regional study context do not allow a generalization of this conclusion. In addition, a potential line of research is the extension of the applied framework to other geographical contexts and to time spans that allow the monitoring of farmers' perspectives.

Learning orientation is clearly a key factor for farmers to demand RES. This conclusion also applies to education level, included as a control variable in our study[4], and which appears to be more relevant than other human capital and structural variables such as age and holding size. Previous research suggests that young farmers and large holdings are more inclined to innovate (Diederen *et al*., 2002), which underlines the need for further research, perhaps in other EU regions with a wider range of ages and farm sizes than in Valencia, a region where small holdings and an aged farming population dominate. Learning orientation and education enhance RES' effectiveness. However, the most innovative firms do not attach a high value to extension services, inviting reflection about how RES function as simple technical providers, perhaps of a bureaucratic nature, rather than as entrepreneurship accelerators.

The on-going work within the present programing period for RDP at the EU stress the promotion of operational groups, networking, and regional technology centres to enhance innovation and create a symbiotic system adapted to each local context. This paper has suggested lines of research for an evaluation of the role of advisory and knowledge services to support innovation policies.

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