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Factors related to the adoption of organic farming in Spanish olive orchards

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Abstract

The area given over to the cultivation of organic olive trees in Spain has greatly increased in the last ten years. The diffusion of organic farming is desirable since its principles are in line with the aim of the current EU Common Agricultural Policy to harmonise agrarian production and environmental protection, and to encourage the production of quality agricultural goods. This paper characterises organic olive growers and farms in the south of Spain and compares them to their conventional counterparts. Information was gathered in a survey of 322 olive growers. The organic growers differed from their conventional counterparts in that their orchards were less productive and in the more part-time nature of their dedication to agriculture. They were also younger, more involved in management and administration of the holding, attended more courses, were more commonly members of agricultural associations, received more information via the Andalusian Committee for Organic Agriculture (a control, certification and training organization), had a more negative opinion regarding the use of chemicals, and believed that organic agriculture required more time and effort but provided greater returns.

Additional key words: adoption factors, diffusion of innovations, *Olea europaea* L., organic practices, technological innovations.

Resumen

Factores relacionados con la adopción de las prácticas ecológicas en el olivar español

La superficie dedicada al cultivo ecológico del olivo en España se ha incrementado notablemente en la última década. La difusión de la agricultura ecológica es un objetivo deseable dado que sus principios están en consonancia con la actual tendencia de la Política Agraria Común de armonizar la producción agraria con la protección medioambiental y la obtención de productos de calidad asegurada para los consumidores. En el presente trabajo se trata de caracterizar a los agricultores y explotaciones agrarias ecológicos frente a los convencionales del sur de España. La información de base se ha obtenido de una encuesta realizada a 322 olivareros. Los resultados muestran que los olivareros ecológicos se diferencian de los convencionales en: explotaciones de menor productividad, mayor dedicación a tiempo parcial y menos años en la agricultura, más jóvenes, mayor dedicación a la administración y gestión de su explotación, mayor asistencia a cursos, mayor pertenenencia a asociaciones agrarias, mayor información a través del Comité Andaluz de Agricultura Ecológica (un organismo de control, certificación y formación, en el momento de realización del trabajo), opinión más negativa del uso de químicos y sobre el tiempo y esfuerzo que requieren la agricultura ecológica pero más positiva sobre su rentabilidad.

Palabras clave adicionales: difusión de innovaciones, factores de adopción, innovaciones tecnológicas, *Olea europaea* L., prácticas ecológicas.

Introduction

The impressive growth experienced by organic olive farming in Spain stands out within the general increase in organic food production seen over the last ten years. The area given over to organic olive farming increased from 1,068 ha in 1991 to 91,209 ha in 2003; in 2003 some 13% of the country's total organic production land was occupied by olive orchards (Figure 1). Moreover, olive cultivation is the second most important organic crop in Spain after cereals and leguminous plants[1] (MAPA, 1992 - 2004), at least as far as cultivated area is concerned. The expansion of

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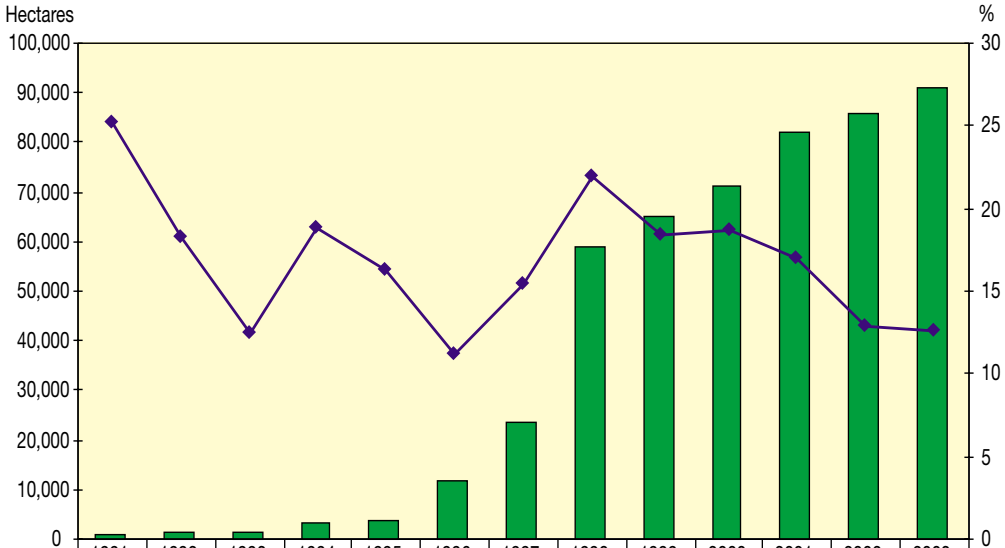
[1] Grasses, forage and prairie production are not considered here as cultivated plants.



	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Organic olive grove surface (ha)	1,068	1,430	1,450	3,241	3,912	11,596	23,553	59,011	65,018	71,351	82,246	85,967	91,209
Organic olive/organic total surface (%)	25.22	18.20	12.42	18.83	16.25	11.18	15.48	21.90	18.46	18.73	16.96	12.93	12.58

Figure 1. Evolution of organic olive area in Spain (1991-2003). *Source:* MAPA (1992-2004).

organic olive cultivation is understandable: the conversion to organic farming is relatively simple since conventional (chemical) olive cultivation requires a relatively small use of synthetic chemicals (Parra López and Calatrava Requena, 2002a).

Despite this increase in organic olive production, most Spanish olive groves are still cultivated according to conventional practices. Just 3.6% of olive land in Spain was cultivated according to organic techniques in 2001 (MAPA, 1992-2004; 2000). Indeed, in Andalusia (southern Spain), the foremost olive-growing region of the world, only 2.2% of olive land was cultivated in this way (MAPA, 1992-2004; Junta de Andalucía, 1999) despite the region being the most important in the country in terms of the area given over to organic olive production in 2003. Though for now organic production is relatively restricted in Andalusia, the region has great potential for development in the coming years.

Although studies on organic olive farming and olive oil are beginning to become abundant, few have dealt with the process of diffusion/adoption organic farming, even though this type of information is in great demand in the olive sector. Among those available, Lampkin and Padel (1994) analysed the characteristics, motives and barriers to organic farming adoption from an international perspective, while Diebel *et al.* (1993) analysed potential economic barriers to the adoption of low-input agriculture using mathematical non-linear programming. In Spain, Chinchilla Fernández (1999) used sociological techniques to analyse the role of the different parties involved in the diffusion of organic practices (from the research level to the transfer of technology to farmers) among Andalusian olive growers. The authors' previous work (Parra López and Calatrava Requena, 2002a; 2002b), which dealt with the same items but in less depth, is a direct forerunner of the present paper. In addition, Parra López (2003) and Parra López and Calatrava Requena (2004) analysed the diffusion over time of organic farming as a technological innovation in Andalusian olive cultivation in three scenarios according to the yields of different olive orchards. Organic and conventional farming practices —and in some cases their environmental impacts— have also been compared, generally from an interdisciplinary perspective (Ardenclarke and Hodges, 1987; 1988; Mawampanga and Debertin, 1996; Berentsen *et al.*, 1998; Clark *et al.*, 1998; Conacher and Conacher, 1998; DEPA, 1999; Sánchez Jiménez, 1999; Stolze *et al.*, 2000; Wells *et al.*, 2000; Hansen *et al.*, 2001; Rigby *et al.*, 2001; Pacini *et al.*, 2003; 2004; Parra López *et al.*, 2004; and Rasul and Thapa, 2004).

The great potential of organic olive farming in the south of Spain, and the scarcity of specific regional studies concerning the diffusion of organic practices, justify interest in the present work, which falls within the paradigm of the diffusion of innovations (Rogers,

1995). The latter identifies factors associated with the adoption of innovations, in this case organic agricultural system. Grower characteristics (age, possession of a formal or informal education and training, dedication to agriculture, access to information channels, opinions and attitudes toward organic farming, etc.) and farm characteristics (size, yield, olive varieties, irrigation, slope, etc.) were analysed to see which are related to the adoption of organic practices. It is important to understand that the factors analysed are statistically related to the adoption of organic agriculture, although it is impossible to determine whether they are causes or effects. However, the model constructed attempts to include only those that would appear to be causes (e.g., sources of knowledge concerning organic agriculture), and to avoid those that are clearly effects (e.g., no-use of chemicals). Causality analysis would require analyses over a long period of time, which this is beyond the scope of this paper.

Methodology

Based on the modern conception of the classical theory of the diffusion of innovations (Rogers, 1995), Andalusian olive growers were surveyed between October 2000 and June 2001 regarding the diffusion/ adoption of organic practices. The survey consisted of a structured questionnaire that was completed during face-to-face interviews of organic and conventional olive growers. A total of 322 growers were interviewed, one half of which followed organic cultivation practices, the other half of which followed conventional practices. The sample was stratified by zone (according the number of organic olive growers officially registered in each) according to the data of the Andalusian Committee for Organic Agriculture-*Comité Andaluz de Agricultura Ecológica*[2] (CAAE, 2000). The same number of organic and conventional olive growers were interviewed in each zone to ensure the comparability of responses.

The questionnaire included several groups of questions dealing with different topics:

— Farm characteristics (area cultivated, yield, year of plantation, varieties of olives, tenure, tree density, slope of the land, etc.).

— Dedication to agriculture (the importance of agriculture in the interviewee's income, number of years devoted to agriculture, type of work performed, training in agriculture, etc.).

— Degree of contact with sources of information (attendance at courses and conferences on agricultural topics, the amount of reading undertaken regarding agricultural topics, membership of agrarian and non-agrarian organisations, place of residence, trips outside the place of residence, etc.).

— Assessment of other factors from a grower's point of view (economic profits, avoidance of risk, personal prestige, environmental protection, production of healthy products, etc.).

— Steps leading to individual adoption or rejection of organic practices (knowledge of organic olive growing, sources of information through which the existence of organic cultivation was discovered, sources of further information, and the moment when organic practices were either adopted or rejected, etc.).

— Attitude towards organic agriculture as an innovation (image that the interviewee has of these practices, economic advantages offered, time and effort saved, social prestige, etc.).

— Personal information (age, sex, marital status, amount of formal education).

A binomial logit model was used to model growers' behaviour regarding the adoption of organic farming. The dependent variable was the main agricultural system used by the olive growers (organic or conventional) while the independent variables were the analysed factors. Prior to the construction of the model, the dependence between each of the independent variables (answers to the survey questions) and the dependent variable was individually tested ($\alpha > 0.05$). The most suitable statistical tests were used in each case according to the nature of the answer[3]. This bivariate analysis allows the selection of initial variables to be introduced into the model (Table 1).

The binomial logit model included only some of the initial variables identified. These were the factors that, jointly, were significantly associated with the adoption of organic farming. Thus, some of the factors shown to be individually related to the adoption of organic farming in bivariate analysis do not appear in the logit model, although all the factors in the logit model are

[2] At the time of the survey the CAAE was the only organisation controlling and certificating organic farming in Andalusia, according to Council Regulation (CEE) No. 2092/91 (OJ, 1991). This public organisation provided growers training in organic techniques.

[3] Chi-squared tests for contingency tables and bivariate logits were mostly calculated using SPSS 10.0 and 11.0 software for Windows.

Table 1. Initial variables individually related to the agricultural system used

Question block	Variable	Survey question
Plantation characteristics	PRODUCTIV	Productivity of the plantation (olive yield in kg of olives ha^{-1})
Dedication of the interviewee to agriculture	INCOM_AGR	Importance of agricultural activity in final income
	DEDIC_AGR	Years dedicated to agriculture
	WORK	Type of work carried out directly on the farm
	COURSES	Agricultural training through courses, conferences, etc.
Contact with sources of information	ATRIA	Membership of ATRIA (Association for Integrated Pest Management)
	EXTENS	Frequency of contacts with local agriculture extension agencies
Assessment of different factors	ENVIRONM	Importance given to respect for the environment
	HEALTH	Importance given to obtaining healthy products
	CHEMICAL	Opinion on the use of synthetic chemical inputs and their influence on human health
Process followed after finding out abour organic practices	KN_COOP	First knowledge of organic olive farming through Co-operative or SAT (Agrarian Transformation Society)
	KN_CAAE	First knowledge of organic olive farming through the CAAE (Andalusian Committee for Organic Agriculture)
	KN_HEADQ	First knowledge of organic olive farming through provincial headquarters of the official agriculture services
	KN_OTHER	First knowledge of organic olive farming through other sources
Attitude toward organic agriculture	PROFIT	Opinion on the economic profitability of olive farming in the interviewee's zone
	TIME_EFF	Opinion on the time and effort saving of organic agriculture
	PREST	Opinion on the social prestige afforded by cultivating in an organic manner
Personal data	AGE	Age of the interviewee

bivariately related to the agricultural system used by growers.

Since the classic study on the diffusion of innovations by Ryan and Gross (1943) from the standpoint of rural sociology, which gave rise to the so called IOWA model, the most important areas concerning the diffusion of innovations, and the methodology for analysing them, have been defined. However, since the 1970s, some of the assumptions associated with the theory behind the diffusion of innovations have been questioned, leading to adjustments to the classical theory and the development of new approaches to its understanding. The extended-classical theory (Rogers, 1995) was used for the present work, which answers the main criticisms made of the classic model:

a) *The pro-innovation bias.* It is very common to suppose that an innovation is always an improvement for all its potential adoptees (Rogers and Shoemaker, 1971), and that its rejection, abandonment or re-invention is attributable to «irrational» behaviour. In the present paper, it was not assumed that organic cultivation was superior to conventional practises. The following were therefore analysed to avoid bias: (1) the attitude of the interviewee towards organic agriculture (see Table 1), focusing on the subjective perception of growers regarding the advantages that organic cultivation might offer them (e.g., economic advantages, time and effort sparing, social prestige etc.), (2) the concordance of organic farming with the values, beliefs and needs of growers, and the assessment of factors such as care for the environment, the will to raise healthy foods and risk aversion, etc. (as suggested by Cimadevilla, 2000) (see Table 1), (3) the possibility of rejection and abandonment via the inclusion of specific questions in the questionnaire. Finally, a multicriteria comparison was performed of the two systems, including economic, technological, environmental and sociocultural issues; earlier work revealed organic olive cultivation to show an overall better performance than conventional cultivation (Parra López, 2003; Parra López *et al.*, 2004).

b) *The individual-blame bias*. It is common to focus only on the features of individuals (usually economic or psychological in nature, i.e., intra-individuals variables) without regard for the influence upon them of other individuals (inter-individuals variables) or the

characteristics of the system to which they belong (system variables). In this paper a holistic approach was attempted. The authors' previous work shows the great importance of the geographic location of individuals in the year of adoption of organic practices, independent of their personal characteristics (Parra López, 2003).

c) *Origin of the innovation*. Traditional diffusion research centres on certain phases of the diffusion process (adoption and diffusion) and fails to analyse others (the recognition of problems and needs, research, development, marketing and the analysis of the consequences of adoption) (Rogers, 1995). In our previous work we analysed the origin of organic agriculture from the perspective of the *Theory of Induced Innovation* (Ruttan and Hayami, 1984; 1989), and showed that the development of organic practices in olive orchards as a technological innovation arises because of the autonomous development of science and technology and new demands made by society (Parra López, 2003).

d) *Existence of incentives*. It is interesting -but not very common- to study the influence of positive and negative incentives (subsidies and taxes/punishments respectively) on the diffusion of innovations. The adoption rate of organic olive-growing would appear to be closely related to the subsidies available, especially in less productive regions (Parra López, 2003).

e) *Consequences of adoption*. Since the 1970s, following the disastrous consequences of the rash implantation of Green Revolution principles in countries different to those in which they were defined, studies of innovation diffusion have tried to analyse the foreseeable consequences of adopting innovations. Our earlier work shows organic olive growing to have greater social value than conventional cultivation (Parra López, 2003; Parra López *et al.*, 2004), especially in less productive conditions (greater generation of employment, greater contribution to social justice, and better performance in disadvantaged regions). However, the diffusion of organic agriculture is slowed down by resistance to change.

Results

Before presenting the results obtained with the logit model, a brief review of the answers regarding the most important variables of the questionnaire is helpful.

Table 2. Description of the initial continuous variables

	Conventional		Organic	
	Mean	**VC**	**Mean**	**VC**
PRODUCTIV	2,126.92	0.75	1,532.05	0.85
DEDIC_AGR	26.50	0.67	22.16	0.71
AGE	51.05	0.29	47.27	0.27

VC: variation coefficient.

Table 2 shows that the mean farm productivity (PRODUCTIV) of the organic olive growers to be lower than that of conventional growers, that organic growers tend to be younger (AGE), and that they have spent fewer years dedicated to agriculture (DEDIC_AGR).

With respect to the categorical variables, it is interesting to note that 39.40% of the organic olive growers had contact with local agriculture extension agencies (EXTENS) while the same can be said of only 23.10% of conventional growers (Table 3). Organic olive growers were also more likely to attend courses and conferences on agrarian topics (COURSES) and be members of an association for integrated pest management (ATRIA)[4]. Moreover, first contact with organic agriculture via a co-operative or «agricultural transformation society» [ATS] (KN_COOP), the Andalusian Committee of Organic Agriculture (KN_CAAE), the provincial headquarters of the official agriculture services (KN_HEADQ) or some other source (KN_OTHER) was significantly more common among the organic olive growers.

Table 4 shows the logit model. Different groups of survey questions were differentiated in order to discuss the most important results obtained with the model. Tables of relationships were produced for the categorical variables of the model with more than two levels (Tables 5 to 9). In these tables, the numbers of the rows and columns represent the codes for the responses to the survey questions. Reference categories are shown in the rows and the category with which these are compared in the columns. The level of significance and the direction of influence of the different values obtained are shown with respect to the reference categories.

[4] Association for Integrated Pest Management-*Asociación para el Tratamiento Integrado en Agricultura (ATRIA)*. These associations deal with the implementation of integrated farming techniques.

Table 3. Percentage of answers to some initial categorical variables

	Extents			Courses		Atria	
	CON	ORG		CON	ORG	CON	ORG
Some contact	23.10	39.40	Yes	9.68	22.37	16.56	41.72
None contact	76.90	60.60	No	90.32	77.63	83.44	58.28
Total	100.00	100.00	Total	100.00	100.00	100.00	100.00

	KN_COOP		KN_CAAE		KN_HEADQ		KN_OTHER	
	CON	ORG	CON	ORG	CON	ORG	CON	ORG
Yes	27.59	40.12	2.07	11.11	0.69	4.32	0.00	3.70
No	72.41	59.88	97.93	88.89	99.31	95.68	100.00	96.30
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

CON: conventional. ORG: organic.

Table 4. Binomial logit model (0 = conventional, 1 = organic) regarding the olive productive system used

	Coefficient	Standard error	Degree of freedom	Significance	Sign. level	Direction
PRODUCTIV	–0.001	0.000	1	0.000	**	(–)
INCOM_AGR			3	0.008	**	
INCOM_AGR(1)	–1.523	0.566	1	0.007	**	(–)
INCOM_AGR(3)	–0.509	0.578	1	0.379	ns	(–)
INCOM_AGR(4)	–1.940	0.613	1	0.002	**	(–)
DEDIC_AGR	–0.022	0.010	1	0.029	*	(–)
WORK			3	0.013	*	
WORK(2)	–2.482	0.858	1	0.004	**	(–)
WORK(3)	–1.294	0.714	1	0.070	ns	(–)
WORK(4)	–3.066	1.387	1	0.027	*	(–)
COURSES	1.105	0.486	1	0.023	*	(+)
ATRIA	2.157	0.448	1	0.000	**	(+)
CHEMICAL			3	0.001	**	
CHEMICAL(1)	1.970	0.505	1	0.000	**	(+)
CHEMICAL(2)	1.599	0.574	1	0.005	**	(+)
CHEMICAL(4)	0.236	1.869	1	0.899	ns	(+)
KN_CAAE	3.242	0.910	1	0.000	**	(+)
PROFIT			3	0.000	**	
PROFIT(2)	–1.522	0.470	1	0.001	**	(–)
PROFIT(3)	–1.585	0.488	1	0.001	**	(–)
PROFIT(4)	–1.514	0.628	1	0.016	*	(–)
TIME_EFF			3	0.002	**	
TIME_EFF(2)	1.212	0.493	1	0.014	*	(+)
TIME_EFF(3)	2.014	0.525	1	0.000	**	(+)
TIME_EFF(4)	0.910	0.914	1	0.319	ns	(+)
Constant	1.414	1.137	1	0.214	ns	

Likelihood Ratio (LR) = 162.397. Degrees of Freedom = 20. Signification = 0.000
–2 log likelihood = 242.059
% correct classification = 81.5%

** $\alpha > 0.01$. * $\alpha > 0.05$. ns: not significant. The meaning of the name of variables can be found in Table 1. The levels of the categorical variables are shown in Table 5 to Table 9.

Table 5. Relationship between the different categories of «Importance of agricultural activity in final income»

	INCOM_AGR											
Categories	**1**			**2**			**3**			**4**		
1. Total												
2. Partial main	0.007	**	(–)									
3. Partial secondary	0.066	ns	(–)	0.379	ns	(+)						
4. Marginal	0.344	ns	(+)	0.002	**	(+)	0.011	*	(+)			

** $\alpha > 0.01$. * $\alpha > 0.05$; ns: not significant.

Farm characteristics

Olive farm productivity (yield, kg of olives ha^{-1}) (PRODUCTIV) was significantly ($\alpha > 0.01$) and inversely related to the implementation of organic farming techniques by the olive growers (Table 4). High productivity implied an increased likelihood of the grower following conventional methods: the mean productivity of conventional olive growers was 2,126.92 kg of olives ha^{-1} compared to 1,532.05 kg ha^{-1} for organic growers (Table 2). The reason may lie in the fact that organic olive orchards are more common in areas where the agricultural conditions are not optimal, or in an intrinsic drop in production associated with organic techniques. The latter is more likely since (1) the conventional and organic growers selected were in close proximity to avoid the distortion of results due to spatial reasons, and (2) neither the slope, land quality, orchard age, acreage, plantation density, irrigation techniques, the presence of crops among the trees, the orientation of production towards oil or olives nor the degree of erosion significantly differed between the two types of orchard in this survey.

Dedication of the interviewee to agriculture

The importance of agriculture in the income of the interviewees (INCOM_AGR) was very significantly related ($\alpha > 0.01$) to the agricultural system used. Table 5 shows that partial dependence on agriculture as a source of income (irrespective of whether mainly or secondarily) significantly increases the probability of a farmer following organic methods compared to those who either totally or marginally depend on agriculture. Thus, it was more common for organic olive growers to work part-time in this activity.

The greater number of years dedicated to agriculture (DEDIC_AGR), the lower the probability growers had of following organic methods (Table 4). Organic growers had usually worked for less time in agriculture. This is generally due to their being younger, as suggested by the bivariate analysis performed. The organic olive growers had worked in agriculture for a mean of 22.16 years compared to 26.50 years for conventional growers (Table 2).

With respect to the type of work performed directly on the farm (WORK), interviewees who performed management tasks, whether they also worked in the fields or not, were more likely to be organic growers than those who simply worked in the field (Table 6). The feature that seems to differentiate organic olive growers from their non-organic counterparts is their direct involvement in the administration of the holding, i.e., the rational control of the production process.

As for agricultural training, the most significant difference between organic and non-organic growers lay in the number of courses and conferences attended

Table 6. Relationship between the different categories of «type of work carried out directly on the farm»

	WORK											
Categories	**1**			**2**			**3**			**4**		
1. Just management												
2. Just physical work	0.004	**	(+)									
3. Both	0.070	ns	(+)	0.022	*	(–)						
4. None	0.027	*	(+)	0.645	ns	(+)	0.138	ns	(+)			

** $\alpha > 0.01$. * $\alpha > 0.05$; ns: not significant.

etc. (COURSES). Conventional growers attended significantly fewer ($\alpha > 0.05$, see Table 4). Moreover, 22.37% of the organic olive growers declared having been trained in agricultural subjects by attending courses and conferences compared to only 9.68% of the conventional growers (see Table 3).

Contact with sources of information

With respect to association membership, and taking into account the vast number of different possibilities (e.g., co-operatives, ATS, unions, ATRIA, etc.), only belonging to an ATRIA was related to adopting organic olive production: 41.72% of the organic growers belonged to an ATRIA compared to 16.56% of the conventional growers (see Table 3).

Assessment of different factors from the point of view of growers

The opinion of growers regarding the use of synthetic chemicals and their influence on human health (CHEMICAL) was also related to the agricultural system used. Growers with more extreme opinions (categories 1 and 2 on Table 7) behaved in significantly different ways to those with more moderate opinions. The former were more likely to be organic growers.

The process of diffusion: steps between attaining knowledge of the technique until its adoption or rejection

Having found out about organic practices through the CAAE (KN_CCAE) was the only factor that increased the likelihood of adopting such techniques according to the logit model. Some 11.11% of the present organic growers heard of the existence of organic agriculture through the CAAE, compared to 2.07% of the conventional growers (Table 3).

Interviewee attitude towards organic agriculture

With respect to opinions on economic profitability (PROFIT), the only significant difference seen (according to the logit model) was between those who believed organic orchards to be more profitable than the conventional type and all other possible opinions (even when growers confessed they had no idea). A clear, positive opinion regarding the profitability of organic agriculture was far more commonly held by those who practised it (Table 8).

Significant differences were found between the two types of growers with respect to their opinion on the time and effort saved by organic agriculture (TIME_EFF). Organic growers believed that organic methods required more time and effort while conventional growers had the opposite opinion (Table 9).

Personal characteristics of the interviewees

None of the personal characteristics initially taken into account were significantly associated with the adoption of organic growing in the logit model.

Table 7. Relationship between the different categories of «opinion on the use of synthetic chemical inputs and their influence on human health»

	CHEMICAL											
Categories	**1**			**2**			**3**			**4**		
1. All should be prohibited												
2. Dangerous must be prohibited. Restrictions of others	0.351	ns	(+)									
3. Can be used with a greater control	0.000	**	(+)	0.005	**	(+)						
4. All can be used nowadays	0.346	ns	(+)	0.465	ns	(+)	0.899	ns	(–)			

** $\alpha > 0.01$. * $\alpha > 0.05$; ns: not significant.

Table 8. Relationship between the different categories of «opinion on the economic profitability of olive farming in the interviewee's zone»

	PROFIT								
	Categories	**1**			**2**			**3**			**4**
1.	Organic olive farming is more profitable										
2.	Equal profitability	0.001	**	(+)							
3.	Conventional olive farming is more profitable	0.001	**	(+)	0.915	ns	(+)				
4.	Does not know	0.016	*	(+)	0.992	ns	(–)	0.922	ns	(–)	

** $\alpha > 0.01$. * $\alpha > 0.05$; ns: not significant.

Possible ways of potentiating the diffusion of organic olive cultivation

Once the logit model had been constructed, it was used to design specific strategies for potentiating the diffusion of organic olive growing in Andalusia and similar regions. This required two debatable assumptions: (1) that the future behaviour of growers will be the same as that seen until now, and (2) that the specific variables selected actually cause grower behaviour and are not an effect (it has already been noted that the factors analysed could be causes or effects - or perhaps not even causally related to the adoption of organic techniques at all). The first assumption involves linearity in terms of grower response; this is very common in mathematical modelling. The second assumption is acceptable if the predictive variables are carefully chosen. Indeed, selected variables in this paper can be understood (with no conceptual doubt) as causes rather than consequences of grower orientation (conventional or organic).

For analytical purposes, the conventional olive growers were classified into two types: conventional growers with extreme answers (type I), i.e., conventional growers whose answers suggest they are unlikely to become organic growers, and modal conventional olive growers, i.e., those whose characteristics are more common among conventional olive growers. Once characterised, the probabilities of their being *a priori* organic growers, were calculated (Table 10).

Some of the variables of the model (taken as causes rather than effects of grower behaviour) could be easily managed by public institutions in a hypothetical strategy aimed at encouraging the adoption of organic olive growing, including:

1. The promotion of agricultural training and education through courses, conferences, etc.
2. Support for the development and creation of specialised public or private organisations dealing with the diffusion of environmentally friendly agricultural techniques (such as ATRIA etc.).
3. Support for training in organic farming techniques on the part of specialised organisations (such as the CAAE, etc.).
4. The incorporation of young people into agriculture.

Table 9. Relationship between the different categories of «opinion on the saving of time and effort in organic agriculture»

	TIME_EFF								
	Categories	**1**			**2**			**3**			**4**
1.	Organic agriculture saves time and effort										
2.	There is no difference	0.014	*	(–)							
3.	Organic agriculture requires more time and effort	0.000	**	(–)	0.043	*	(–)				
4.	Does not know	0.319	ns	(–)	0.725	ns	(+)	0.190	ns	(+)	

** $\alpha > 0.01$. * $\alpha > 0.05$; ns: not significant.

Table 10. Classification of conventional olive growers

Code	Question	Type I Conventional farmer with extreme answers	Type II Modal conventional farmer
PRODUCTIV*	Productivity of the olive farm (kg of olives ha^{-1})	2,126.92	2,126.92
INCOM_AGR	Importance of agricultural activity in final income	Total (≥ 80%)	Marginal (≤ 20%)
DEDIC_AGR*	Years dedicated to agriculture	26.5	26.5
WORK	Type of work carried out directly on the farm	None	Both management and physical work
COURSES	Agricultural training through courses, conferences, etc.	No	No
ATRIA	Membership of ATRIA (Association for Integrated Pest Management)	No	No
CHEMICAL	Opinion on the use of synthetic chemical inputs and their influence on human health	They can be used with a greater control	All should be prohibited
KN_CAAE	First knowledge of organic olive farming through the CAAE (Andalusian Committee for Organic Agriculture)	No	No
PROFIT	Opinion on the economic profitability of olive farming in the interviewee's zone	Organic olive farming is as profitable as the conventional one	Organic olive farming is more profitable than the conventional one
TIME_EFF	Opinion on the time and effort saving of organic agriculture	Organic agriculture saves time and effort	Organic agriculture requires more time and effort than conventional one
Prob (organic)		0.10%	29.86%

* The value of continuous variables can not be categorized and its mean has been used to calculate probabilities of both type I and type II farmers.

5. The development of training programs related to agricultural management and business administration.

As a simulation exercise with our model, if variables (1), (2) and (3) are managed at the same time, conventional growers with less likelihood of following organic techniques (type I) would increase their probability of doing so from 0.10% to 39.92%. The same strategy applied to the modal conventional olive growers (type II) would increase this probability from 29.86% to 99.65%. This highlights the importance of adopting such strategies.

Conclusions

On the basis of the analysis performed, it can be concluded that:

— The process of adopting organic techniques in olive tree cultivation is statistically related to a series of identified variables. However, the analysis made does not allow causality relationships to be established.

In this paper, the adoption phase of the diffusion process was focused upon. The authors' earlier work (Parra López, 2003; Parra López *et al.*, 2004) facilitated a more holistic approach to the study of the diffusion of organic olive techniques.

— The adoption of organic techniques is inversely related to the productivity (yield) of olive tree cultivation. In all likelihood this is due to a reduction in productivity inherent to organic farming, particularly in the first steps of the conversion process.

— Part-time labour is more frequent among organic olive growers.

— Organic growers have usually spent fewer years dedicated to agriculture than conventional growers. This can be explained, at least partially, in terms of their younger average age.

— Organic growers often spend more time than conventional growers personally tending to farm administration and managerial tasks.

— Organic olive growers attend training courses much more frequently than do traditional growers.

— Membership of an ATRIA (Association for Integrated Pest Management) is much more common among organic growers.

— Opinions regarding the use of synthetic chemicals are, logically, more restrictive among organic growers.

— Having found out about organic farming through the CAAE (Andalusian Committee for Organic Agriculture) was more common among those who became organic growers.

— Organic and conventional growers' opinions on the economic returns and labour requirements of organic farming differ. Organic growers believe that organic cultivation requires more time and effort than conventional growing, but generates greater returns.

— Working on a series of strategic variables can boost the adoption of organic techniques (assuming the linearity and causality of the studied variables). The following steps are suggested: (a) Agricultural training and education should be improved via sponsoring from specialised bodies (such as the ATRIA and the CAAE etc.); (b) Young growers should be incorporated into organic cultivation. Training programs on management and administration could indirectly create greater awareness and recognition of organic farming.

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References

ARDENCLARKE C., HODGES R.D., 1987. The environmental-effects of conventional and organic biological farming systems. 1. Soil-erosion, with special reference to Britain. Biol Agric 4(4), 309-357.

ARDENCLARKE C., HODGES R.D., 1988. The environmental-effects of conventional and organic biological farming systems. 2. Soil ecology, soil fertility and nutrient cycles. Biol Agric 5(3), 223-287.

BERENTSEN P.B.M., GIESEN G.W.J., SCHNEIDERS M.M.F.H., 1998. Conversion from conventional to biological dairy farming: economic and environmental consequences at farm level. Biol Agric 16(3), 311-328.

CAAE, 2000. Datos de los olivicultores ecológicos en Andalucía a 15 de marzo de 2000 [Information on organic olive growers in Andalusia on 15 March 2000]. Comité Andaluz de Agricultura Ecológica-Andalusian Committee of Organic Agriculture. Work document for internal use.

CHINCHILLA FERNÁNDEZ M., 1999. Comunicación e innovación en el sector olivarero andaluz. Una referencia especial al cultivo ecológico [Communication and innovation on the Andalusian olive sector. An special reference to organic farming]. Final Year Dissertation. School of Advanced Agricultural Engineering Studies (ETSIAM). Univ. of Córdoba, Spain.

CIMADEVILLA G., 2000. Comunicación de innovaciones ambientales: Para un replanteo de la teoría clásica [Communication of innovations: Towards a reconsideration of classical theory]. Agroecología e Desenvolvimento Rural Sustentâvel 4, 28-31.

CLARK M.S., FERRIS H., KLONSKY K., LANINI W.T., VAN BRUGGEN A.H.C., ZALOM F.G., 1998. Agronomic, economic, and environmental comparison of pest management in conventional and alternative tomato and corn systems in northern California. Agr Eco Env 68, 51-71.

CONACHER J., CONACHER A., 1998. Organic farming and the environment, with particular reference to Australia: a review. Biol Agric 16, 145–171.

DEPA, 1999. Økologiske scenarier for Danmark. Danish Environmental Protection Agency. Available in http://www.mst.dk/199903publikat/87-7909-292-6/oekologi.pdf [7 March 2000].

DIEBEL P.L., TAYLOR D.B., BATIE S.S., 1993. Barriers to low-input agriculture adoption: a case study of Richmond County, Virginia. Am J Altern Agr 8(3), 120-127.

HANSEN B., ALRØE H.F., KRISTENSEN E.S., 2001. Approaches to assess the environmental impact of organic farming with particular regard to Denmark. Agr Eco Env 83, 11-26.

JUNTA DE ANDALUCÍA, 1999. Declaraciones de olivar de la Campaña 1.997/98 [Olive grove declarations year 97/98]. Andalusian Autonomous Government. Work document for internal use.

LAMPKIN N., PADEL S., 1994. Conversion to organic farming: an overview. In: The economics of organic farming: An international perspective (Lampkin N., Padel S., ed.), CAB International, Wallinford UK.

MAPA, 1992-2004. Estadísticas 1991-2003. Agricultura Ecológica. Spain. [Statistics. 1991 to 2003. Organic farming in Spain]. Spanish Ministry of Agriculture, Fishery and Food, Madrid.

MAPA, 2000. Hechos y cifras del sector agroalimentario español 2000 [Facts and Figures of the Spanish Sector of Agriculture and Food 2000]. 5th edition. Spanish Ministry of Agriculture, Fishery and Food, Madrid. Available in http://www.mapya.es [several dates].

MAWAMPANGA M.N., DEBERTIN D.L., 1996. Choosing between alternative farming systems: an application of the analytic hierarchy process. Agr Econ 8(3) Sept, 385-401.

OJ, 1991.Council Regulation (EEC) No 2092/91 of 24 June 1991 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs. Official Journal of the European Union L 198, 1-15.

PACINI C., WOSSINK A., GIESEN G., HUIRNE R., 2004. Ecological-economic modelling to support multi-objective policy making: a farming system approach implemented for Tuscany. Agr Eco Env 102, 349-364.

PACINI C., WOSSINK A., GIESEN G., VAZZANA C., HUIRNE R., 2003. Evaluation of sustainability of organic, integrated and conventional farming systems: a farm and field-scale analysis. Agr Eco Env 95, 273-288.

PARRA LÓPEZ C., 2003. Sistemas de producción ecológica, integrada y convencional en olivar: Estudio de difusión de innovaciones y evaluación multifuncional [Organic, Integrated and Conventional Agricultural Systems in Olive Grove: A Diffusion of Innovations Analysis and Multifunctional Assessment]. Doctoral thesis. Univ. of Córdoba. Spain.

PARRA LÓPEZ C., CALATRAVA REQUENA J., 2002a. Análisis de factores relacionados con la adopción de la forma de producción ecológica en el olivar del sur de España [Analysis of factors related with the adoption of organic farming in the south of Spain olive grove]. Proc. I IFOAM Worldwide Conference on Organic Olive Farming, Sierra de Génave (Jaén), Spain, May 22-24.

PARRA LÓPEZ C., CALATRAVA REQUENA J., 2002b. Adoption factors of the organic practices in the southern Spanish olive farming. Proc. X European Congress of Agricultural Economists, Zaragoza, Spain, Aug. 28-31.

PARRA LÓPEZ C., CALATRAVA REQUENA J., 2004. Estudio de la difusión temporal de la agricultura ecológica como innovación tecnológica en el olivar del sur de España [Temporal diffusion of organic agriculture as a technological innovation in the southern Spanish olive-growing]. Proc. V Jornadas Internacionales de Olivar Ecológico (Ecoliva04), Sierra de Segura, Puente de Génave (Jaén), Spain, May 20-23.

PARRA LÓPEZ, C., CALATRAVA REQUENA J., DE HARO GIMÉNEZ T., 2004. Análisis multifuncional de sistemas agrarios: Aplicación del método del proceso analítico jerárquico al olivar de producción convencional, ecológica e integrada en Andalucía [Multifunctional assessment of agricultural systems: Implementation of the analytic hierarchy process to conventional, organic and integrated Andalusian olive-growing]. Ed. Unicaja, Málaga, Spain.

RASUL G., THAPA G.B., 2004. Sustainability of ecological and conventional agricultural systems in Bangladesh: an assessment based on environmental, economic and social perspectives. Agr Syst 79, 327-351.

RIGBY D., WOODHOUSE P., YOUNG T., BURTON M., 2001. Constructing a farm level indicator of sustainable agricultural practice. Ecol Econ 39, 463-478.

ROGERS E.M., 1995. Diffusion of Innovations. 4th Edition. The Free Press, NY.

ROGERS E.M., SHOEMAKER F.F., 1971. Communication of innovations: a cross-cultural approach. Free Press. NY.

RUTTAN V.W., HAYAMI Y., 1984. Toward a theory of induced institutional innovation. The Journal of Development Studies 20(4), 204-224.

RUTTAN V.W., HAYAMI Y., 1989. El cambio técnico inducido en la agricultura [Induced technical change in agriculture]. Agric Soc 53, 19-72.

RYAN B., GROSS N.C., 1943. The diffusion of hybrid seed corn in two Iowa communities. Rural Sociology 8, 15-24.

SANCHEZ JIMENEZ S., 1999. El control de costes en el cultivo del olivar [Cost control in olive grove]. Doctoral thesis. Univ. of Jaén, Spain.

STOLZE M., PIORR A., HÄRING A., DABBERT S., 2000. The environmental impact of organic farming in Europe. Organic farming in Europe: Economics and Policy, Vol. 6. Univ. of Hohenheim, Germany.

WELLS A.T., CHAN K.Y., CORNISH P.S., 2000. Comparison of conventional and alternative vegetable farming systems on the properties of a yellow earth in New South Wales. Agr Eco Env 80, 47-60.