Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria (INIA)
Available online at www.inia.es/sjar
http://dx.doi.org/10.5424/sjar/2012104-2957

Spanish Journal of Agricultural Research 2012 10(4), 901-910
ISSN: 1695-971-X
eISSN: 2171-9292

What makes a citrus farmer go 'organic'? Empirical evidence from Spanish citrus farming

M. Beltrán-Esteve, A. J. Picazo-Tadeo and E. Reig-Martínez*
Universidad de Valencia, Valencia, Spain

Abstract

Organic farming is increasing its share of total world food output and receiving growing support from policymakers concerned with agricultural sustainability issues. This paper studies the characteristics of citrus farmers in the Spanish region of Valencia that affect their probability of becoming organic farmers. A fair understanding of these characteristics may help policymakers improve the design of agricultural policies aimed at supporting organic citrus practices. As regards the methodology, a probit model is estimated with information from a sample of conventional and organic citrus farmers obtained from a survey designed for a larger research project aimed at analysing Valencian citrus farming. Our main finding is that university education and agricultural professional training both increase the probability of becoming an organic farmer. Conversely, older farmers, farmers selling their production to foreign markets and those with larger farms and/or managing family farms are less likely to adopt organic citrus farming. The main policy implication is that, in order to support organic citrus production, more attention needs to be paid to improving farmers' technical training and education.

Additional key words: citrus farming; education and professional training; organic *versus* conventional production; probit estimation; Spain.

Resumen

¿Qué conduce a un citricultor a ser "orgánico"? Evidencia empírica a partir de la citricultura española

La agricultura orgánica está aumentando su participación en la producción mundial de alimentos, a la vez que recibe un apoyo creciente por parte de los gestores de la política agraria, preocupados por la sostenibilidad de la agricultura. Este artículo estudia las características de los citricultores en la región española de Valencia que afectan a la probabilidad de que se conviertan en orgánicos. Una correcta comprensión de estas características podría contribuir a mejorar las políticas agrarias dirigidas a apoyar la citricultura orgánica. En relación a la metodología, se estima un modelo probit con información de una muestra de citricultores convencionales y orgánicos procedente de una encuesta diseñada en el contexto de un proyecto de investigación más amplio dedicado a analizar la citricultura valenciana. El principal resultado es que la educación universitaria y la formación profesional agraria aumentan la probabilidad de convertirse en un agricultor orgánico. Contrariamente, los agricultores de mayor edad, los agricultores que orientan parte de su producción a los mercados internacionales y aquéllos con explotaciones de mayor tamaño y/o que dirigen explotaciones familiares cuentan con una menor probabilidad de adoptar la citricultura orgánica. La principal implicación política es que para impulsar la citricultura orgánica debe prestarse especial atención a mejorar la educación y formación agraria de los agricultores.

Palabras clave adicionales: citricultura; educación y formación profesional; España; estimación probit; producción orgánica *versus* convencional.

Introduction

Agricultural policies in developed countries are evolving toward the promotion of more ecologically-friendly farming techniques. Concern for food safety and the spread of non-materialistic values are driving consumers toward organic products. While mainstream farming still relies on the intensive use of chemical inputs for fertilization and crop protection, new alternatives, like organic farming, are being developed to

*Corresponding author: Ernest.Reig@uv.es
Received: 02-04-12. Accepted: 13-09-12

This work has 1 Supplementary Table that does not appear in the printed article but does accompany the paper online.

prevent environmental damages arising from conventional agricultural practices and their negative impacts on consumer and producer health.

Organic farming must be referred to a broader framework that revolves around the concept of sustainable agriculture, an elusive concept which means different things to different people (Lynam & Herdt, 1989; Hansen, 1996; Howe, 1997; Becker, 1997; Rao & Rogers, 2006). Some authors have been inspired by the Brundtland Report (WCED, 1987), which points to the ability of sustainable farming systems to indefinitely meet demands for food and fiber at socially acceptable economic and environmental costs (Crosson, 1999). Others have preferred to list a set of key principles to characterize sustainable agriculture (Pretty, 2008), involving the integration of biological and ecological processes into food production and minimization of the use of non-renewable inputs.

Organic farming aims to create a sustainable agricultural production system. More specifically, organic farming involves maximum reliance on self-regulating ecological or biological processes and renewable resources, while systematic efforts are undertaken to reduce reliance on external inputs (Stolze & Lampkin, 2009). Another characteristic of organic agriculture is the willingness of farmers to contribute to the development of a special market for agricultural produce, able to attract premiums from the concerned consumer.

Some researchers have analyzed the diffusion of organic farming within a global pattern of adoption/diffusion of innovations, treating organic farmers as innovators or early adopters (Padel, 2001). According to innovation theory, innovators are generally better educated than later adopters, and have larger farms and more social contacts outside their local community (Rogers, 1983). In fact, organic farmers are frequently found to be younger than their conventional counterparts, often share an urban background and high educational levels and are endowed with less farming experience. The evidence is not however conclusive concerning differences in farm size.

A number of authors have conducted empirical research into farmers' decisions to convert to organic farming, describing in the process some characteristics of organic farmers. In the UK organic producers were found to be younger than conventional farmers and to have started to work in agriculture later. They were also prone to relying more on other farmers as primary sources of information, in comparison to conventional farmers. The probability of adopting organic farming was also seen to increase if the farmer was concerned with environmental issues, believed that organic farming alone could satisfy society's needs for food and fiber and the larger the size of the farm household (Burton *et al.*, 1999). Other studies concerning European countries have shown that organic farmers displayed a different ranking of goals with regards to other groups of farmers, because they were the only ones to rank *sustainable and environment-friendly farming* highest (Koesling *et al.*, 2008), and that a low uptake of extension services and particularly a low availability of organic farming specific advisory services were hampering the rate of adoption of organic farming in some cases (Kaufmann *et al.*, 2011). The attitude of professional experts toward organic farming is also important to explain the uptake of organic techniques by farmers and it is positively influenced by a greater acquaintance with organic farming topics and an understanding of natural resource management (Wheeler, 2008; Ingram, 2008).

For a long time, one contentious issue in relation to adopting organic farming has been the relative role of economic *versus* non-economic motivations (Padel, 2008). Some researchers have shown that non-economic concerns are important drivers of farmers' behavior (Rigby *et al.*, 2001). A recent survey of fruit-growers and vegetable producers located in the French Provence-Alpes-Côte d'Azur region (Mzoughi, 2011), has shed light on farmers reasons for selecting alternative crop protection methods —classified into conventional, integrated and organic methods. Moral concerns received significantly more attention from organic farmers, who assigned less importance to economic concerns compared to the rest of farmers.

In Spain, most research has a distinctly regional flavor. On the basis of personal interviews, several types of organic farmers were identified in the regions of Catalonia and Galicia (Armesto-López, 2008). When questioned about the main advantages of adopting organic farming, the highest percentage of replies mentioned ecological reasons, in the first place, and financial ones in the second place (Catalonia), and health in the first place and financial and ecological reasons in the second place (Galicia). Conversely, problems related to product marketing and lower profits were mentioned as the main difficulties hampering the development of organic farming in both regions. The analysis of adoption of organic farming in Andalusian olive-growing areas (Parra-López *et al.*, 2007) has

shown the importance of interpersonal contacts within each of the areas studied, that innovativeness is greater among farmers from traditional and extensive olive-growing areas and that early adopters have similar socioeconomic characteristics to late adopters.

Our focus in this paper is on Spanish organic citrus farming. Organic citrus farming differs in some technical aspects from conventional citrus farming. Organic citrus orchards use compost manure, supplemented with other complex organic materials, and green manure crops of rapid growth also contribute large annual quantities of humus and nutrients. The soil incorporation of pruning remains from trees also helps to improve soil quality, reduces the need for crop fertilizers and contributes to reducing CO_2 emissions. Organic citrus farming helps to maintain biodiversity through ground cover (*i.e.,* alfalfa and wild grasses) and by using hedgerows and also makes better use of limited water resources (Domínguez-Gento, 2008; Porcuna *et al.,* 2010).

Organic citrus farming still represents a small proportion of total farmland devoted to citrus production in the region of Valencia (MARM, 2010), which is the main area of citrus production in Spain. Some reasons explain the slow diffusion of organic citrus farming, namely, the difficulties to isolate small organic citrus farms from intensive plantations, the region's long history of intensive production, the lack of appropriate distribution channels for organic produce in the domestic market and the scarcity of available subsidies to compensate for the higher costs incurred by organic production (Peris & Juliá, 2006). The costliest items in citrus farming are always variable inputs (*i.e.,* irrigation water, fertilizers, and labor), and variable costs per hectare are higher in organic farms. Organic manure is more expensive and difficult to obtain than chemical fertilizers and must be used in greater quantities to meet the requirements of adult plantations, and organic orchards are also substantially more labor-demanding than conventional ones. Finally, yields are lower than in conventional production, thus increasing cost per kilogram and raising the differential break-even point of organic farming (Peris *et al.*, 2005; Peris & Juliá, 2006; Domínguez-Gento, 2007), but market prices are considerably higher than for conventional produce. Features differentiating organic from conventional citrus farming in Valencia are presented in Table 1, where averages have been computed using the sample of farmers which is described in the next Section.

The aim of this paper is to determine the particular characteristics that differentiate organic citrus farmers in Spain from conventional ones, and also to enquire about the motivations that inspire those farmers that have become organic growers. In doing so a probit regression model is estimated to ascertain the main determinants of the adoption of an organic *versus* a conventional farming system.

Table 1. Some characteristics of Valencian citrus farms: organic *versus* conventional

	Mean	Standard deviation	Maximum	Median	Minimum
Organic					
Labor intensity (hours of labor ha^{-1})	203.9	154.2	1,026.7	160.4	28.5
Average yield (kg ha^{-1})					
Oranges	19,175	11,665	69,000	17,640	1,700
Mandarin oranges	15,668	9,433	40,875	14,288	960
Average price (€ kg^{-1})					
Oranges	0.32	0.18	1.0	0.30	0.05
Mandarin oranges	0.40	0.22	1.2	0.34	0.07
Average income (€ ha^{-1})	5,720	4,705	28,800	4,618	153
Conventional					
Labor intensity (hours of labor ha^{-1})	162.8	116.9	745.2	134.13	17.7
Average yield (kg ha^{-1})					
Oranges	33,805	10,248	60,000	34,944	6,000
Mandarin oranges	32,405	11,193	72,000	32,470	5,948
Average price (€ kg^{-1})					
Oranges	0.16	0.07	0.37	0.16	0.05
Mandarin oranges	0.24	0.12	0.75	0.21	0.07
Average income (€ ha^{-1})	6,820	4,916	42,750	5,937	756

Table 2. Sample description: continuous variables

	Mean	Standard deviation	Minimum	Median	Maximum
All farms					
Age (years)	50.6	13.0	20	50	87
Farm size (ha)	2.79	5.29	0.10	1.29	62.17
Organic					
Age (years)	47.9	12.7	20	47	76
Farm size (ha)	2.28	3.33	0.10	1.25	27.4
Conventional					
Age (years)	53.5	12.6	23	53	87
Farm size (ha)	3.35	6.81	0.13	1.49	62.1

Material and methods

The information used in this research comes from a survey designed for a larger research project aimed at analysing both the economic and environmental performance of conventional and organic citrus farming in the Spanish region of Valencia. Valencian organic citrus farmers must be registered with the '*Comité de Agricultura Ecológica de la Comunidad Valenciana*' (CAECV) of the Department of Agriculture of the Valencian government as a condition to obtain a certificate for ecological producers, which enables them to sell their production with the label of ecological citrus production. In 2009, a total of 203 organic citrus farmers were registered with the CAECV and are assumed to constitute the entire population of organic citrus farmers in the region of Valencia. All organic citrus farmers registered by this census were contacted and 153 of them agreed to answer the questionnaire. After removing some outliers and observations with missing data, the sample was made up of 125 farms, which represent 61% of the population of organic citrus farms.

Furthermore, a control group of two hundred conventional citrus farmers was randomly selected by quota sampling citrus farmers' population by citrus farming area; 129 of them answered and 113 remained in the sample after eliminating outliers and observations lacking relevant data. Tables 2 and 3 describe the variables used in this research to explain the decision to become an organic citrus farmer and present some descriptive statistics for both organic and conventional citrus farmers.

The *age* variable indicates the age of the manager, which ranges from 20 to 87 years old, with an average age of 50.6 years; aside from the under-30s and over-80s, which is the case of only 10 farmers in total, the distribution is relatively evenly spread. *Farm size* is a variable that measures the size of the farm and which averages 2.79 ha. The variable *gender* is a qualitative variable that takes a value of 1 if farms are managed by a man and 0 if the manager is female. *University education* and *professional training in agriculture* are both qualitative variables signalling managers who have completed university studies or have vocational training in agriculture, respectively. As can be seen,

Table 3. Sample description: categorical variables (frequency of positive outcomes, %)

	All farms	Organic	Conventional
Organic (1 = organic; 0 = conventional)	52.5	—	—
Gender (1 = male; 0 = female)	93.3	93.6	92.9
University education (1 = yes; 0 = no)	31.9	43.2	19.5
Professional training in agriculture (1 = yes; 0 = no)	4.6	7.2	1.8
Family farm (1 = yes; 0 = no)	91.6	88.8	94.7
Export to foreign markets (1 = yes; 0 = no)	84.5	75.2	94.7
Union membership (1 = yes; 0 = no)	42.4	38.4	46.9
Producers association membership (1 = yes; 0 = no)	29.8	30.4	29.2
Commercialization association membership (1 = yes; 0 = no)	65.1	64.0	66.4
Off-farm work (1 = yes; 0 = no)	81.9	83.2	80.5

almost 32 out of every 100 farmers in the sample have university studies, whereas only 4.6% have professional training in agriculture. *Family farm* is a dummy variable identifying farms which are family businesses, as opposed to cooperatives and other legal forms for citrus farms. One distinguishing feature of citrus farming in Valencia is that farms are mostly family-run (91.6% of the sample). A total of 84.5% of farmers in the sample sell part of their production of citrus produce to international markets, as shown by the average of the qualitative variable *export to foreign markets*.

Union membership, *producers association membership* and *commercialization association membership* are three categorical variables that identify managers who are members of the Unió de Llauradors i Ramaders, AVA-ASAJA or other farmers' unions in the Valencian region (42.4% of farmers in the sample), members of an association of producers (29.8%) or members of a commercialization association (65.1%), respectively. Finally, *off-farm work* is a dummy that takes a value of 1 for farms in which citrus farming is not the only working activity of their managers; the average of this variable in the sample stands at 0.819, showing the great importance of part-time farming in the Valencian citrus farming sector (Picazo-Tadeo & Reig-Martinez, 2005; 2006).

Beyond the averages commented on in previous paragraphs, differences between organic and conventional citrus farms for some variables are important. While organic farmers are, on average, 48 years old, the average age of conventional farmers rises to 53 years. Organic farms are also smaller in size on average (2.28 ha) than conventional farms (3.35 ha). Moreover, 43.2% of organic farmers in the sample have attained university studies, while only 19.5% of conventional farmers have attained this level of education; likewise, 7.2% of organic citrus farmers have professional training in agriculture compared to only 1.8% of conventional farmers. Furthermore, the share of family farms as well as farms that export to foreign markets is lower in the group of organic farmers.

In order to investigate the determinants of the decision of a citrus farmer to go organic, in this paper we use a standard probit regression model (probit analysis was initiated by Bliss, 1934a,b; see Cameron & Trivedi, 2010 for an overview). The result of the decision to convert to organic farming is represented by the observed binary variable *Organic*, which takes a value of 1 if the farmer uses organic citrus farming techniques and 0 if he/she uses conventional production technologies. The probit model can be motivated as a latent variable model. Let us therefore assume that behind our observed variable there is a latent unobservable variable, namely $Organic^*$, so that $Organic = 1$ if $Organic^* > 0$ and $Organic = 0$ if $Organic^* \leq 0$. Formally:

$$Organic = \begin{bmatrix} 1 & if\ Organic^* > 0 \\ 0 & if\ Organic^* \leq 0 \end{bmatrix} \quad [1]$$

Introducing a set of independent variables, namely $X_{Organic}$ to explain our latent variable, allows us to define the equation that describes the probability of experiencing the selecting event, namely Probit ($Organic = 1 \mid X_{Organic}$) = $\alpha X_{Organic}$, α being a vector of unknown regression parameters. Considering the variables used in this research to explain the decision to become an organic citrus farmer, this equation can be linearly stated as:

$$\begin{aligned} Organic^* = {} & \alpha_0 + \alpha_1\, Gender + \alpha_2\, Age + \alpha_3\, Farm\ size + \alpha_4\, University\ education + \\ & + \alpha_5\, Professional\ training\ in\ agriculture + \alpha_6\, Family\ farm + \\ & + \alpha_7\, Export\ to\ foreign\ markets + \\ & + \alpha_8\, Union\ membership + \\ & + \alpha_9\, Producers\ association\ membership + \alpha_{10}\, Commercialization\ association\ membership + \\ & + \alpha_{11}\, Off\text{-}farm\ work + \eta_{Organic} \end{aligned} \quad [2]$$

where $\eta_{Organic}$ is a zero-mean unit-variance normal random variable.

Results

Let us start by expounding the reasons that Valencian citrus farmers claim to be the most important when they decide to change from conventional to organic citrus farming. The organic citrus farmers interviewed in our survey were asked about whether or not a set of motivations had influenced their decision to adopt organic practices for citrus farming. Organic farmers were also asked about their opinion concerning certain factors that might make it difficult to adopt organic citrus farming technologies. Figures 1 and 2 show the results, which display the frequency with which each motivation or factor appeared in the responses of the citrus farmers interviewed.

Regarding the motivations that citrus farmers manifest as the main forces that have driven their decision to go organic, environmental concerns (85.6%), concern about future generations (84.8%), interest in producing high quality products (84.8%) as well as reducing the dependence on agrochemical products (81.6%) are of outstand-

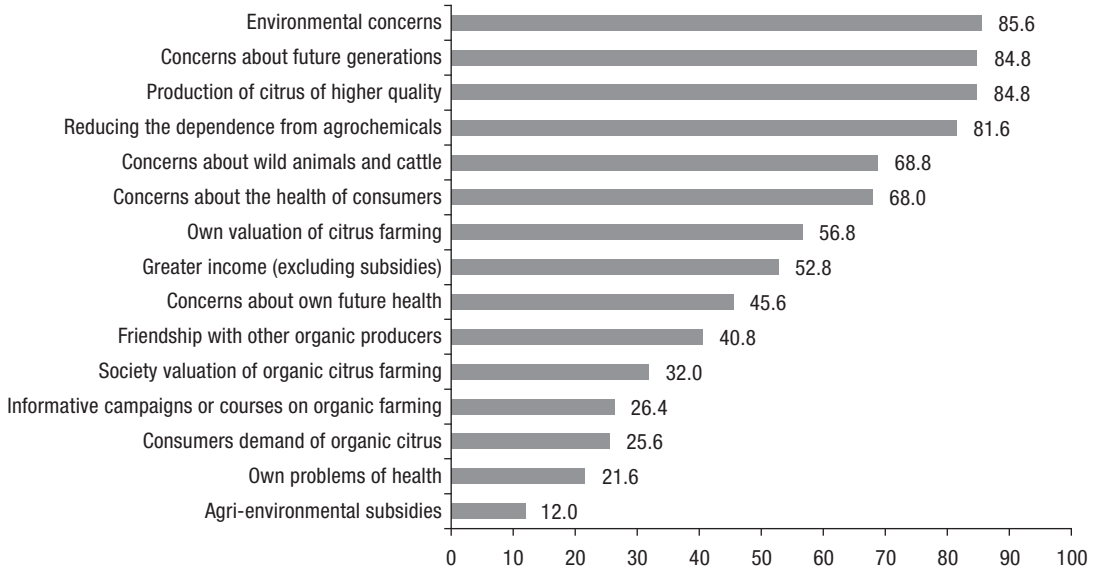

Figure 1. Factors driving the decision to become an organic citrus farmer (frequency of responses in %).

ing importance. Other motivations highlighted by more than half of the farmers interviewed include concerns about wild animals and cattle (68.8%) and health (68%), in addition to the dignity and self-esteem that being an organic farmer provides (56.8%) and the greater income generated by organic citrus farming (52.8%). Furthermore, and regarding the main obstacles that make organic farming difficult, respondents cited a lack of advisory services about organic farming (28.8%), a lack of technical information (24.8%), as well as a lack of information about the commercialization channels for organic farming products (25.6%).

According to these results, environmental and social concerns figure more prominently than purely economic concerns as drivers of farmers' decisions to adopt organic citrus farming. Not only environmental concerns are directly mentioned as the top motivation. Indeed, other issues linked to environmental protection also rank high in farmers' answers, such as the *concern for future generations* —a typical intergenerational sustainability issue—, *reducing dependence on agrochemicals* or *protecting wild animals* —a biodiversity issue. Economic concerns are clearly relevant, but not as much as environmental issues.

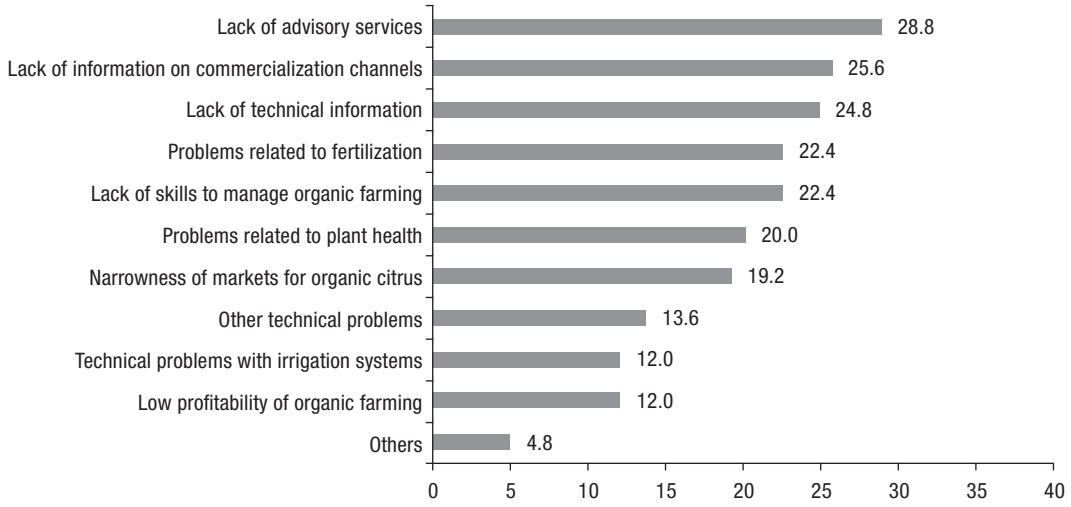

Figure 2. Obstacles to the practice of organic citrus farming (frequency of responses in %).

Table 4. Determinants of citrus production system: organic *versus* conventional

Variable	Estimated parameter[a]	*p*-value	Marginal effect[b]
Gender	–0.0145	0.968	—
Age	–0.0132*	0.080	–0.0052
Farm size	–0.0462**	0.050	–0.0184
University education	0.5923***	0.005	0.2288
Professional training in agriculture	1.1137**	0.016	0.3612
Family farm	–0.8226**	0.021	–0.2929
Export to foreign markets	–0.9444***	0.001	–0.3360
Union membership	–0.2627	0.150	—
Producers association membership	–0.0621	0.758	—
Commercialization association membership	0.0111	0.953	—
Off-farm work	–0.0167	0.942	—
Constant	2.3547***	0.001	—
Log likelihood		–138.46	
LR test (χ^2)[c]		52.40 (0.000)***	
Pseudo R^2		0.159	
Observations		238	
Hits		73.1%	

[a] * Significant at 10%, ** significant at 5% and *** significant at 1%. [b] The marginal effects are only presented for statistically significant variables. [c] Probability of non-significance of the model in brackets.

Let us now expound the results from our probit estimation regarding the determinants of the decision to become an organic citrus farmer. Eq. [2] has been estimated by maximum-likelihood using our sample of 238 Spanish citrus farmers and Stata 12 software (see Cameron & Trivedi, 2010, for details on the estimation procedure). The results for the parameters of interest are displayed in Table 4. The sign of the estimated parameters of each significant explanatory variable records its effect, either positive or negative, on the likelihood of using organic citrus farming practices, respectively. Additionally, the magnitude of this effect is quantified by the marginal effect, which is only reported for variables which are statistically significant.[1]

The equation of the determinants of the decision to adopt organic production techniques is globally significant at the standard confidence levels, according to the results from the *LR* test. The *pseudo-*R^2 is not particularly high, although this is a common result in studies based on the estimation of probit models. The percentage of correct answers provided by the model stands around 73%; however, as shown by the classification of observations in Table 5, it is a little higher for conventional farmers (77.9%) than for organic farmers (68.8%). Furthermore, we have performed a *Kappa* test in order to assess the degree of agreement between observed organic or conventional farms and the classification from our probit model; the *Kappa-statistic* is 0.464 (*p*-value 0.000), which according to the scale proposed by Landis & Koch (1977, p. 165) indicates a moderate agreement.

As regards the variables of interest in the model, we find that both university education and having professional training in agriculture boost the probability of being an organic citrus farmer; in both cases the relationship is statistically significant at standard confidence levels. Furthermore, having university studies and professional training in agriculture increases the probability of using organic technologies by 22.8% and 36.1%, respectively, as shown by the corresponding marginal effects displayed in the last column of Table 4.

Conversely, older farmers, farmers with larger farms, family farms and farmers that sell part of their production to foreign markets are less likely to adopt organic citrus farming techniques; in all cases the effect is statistically significant at standard confidence levels. Concerning the marginal effects of these variables, one more year as regards the age of the farmer reduces the probability of being an organic farmer by 0.5%; similarly, being a family farm and devoting part of citrus production to export reduces the probability of farmers being

[1] We have also estimated our probit model excluding the variables that are non-significant in Table 4. The results are shown in the Suppl Table 1 (pdf) and make no difference.

Table 5. Determinants of citrus production system: Probit prediction power

Classified	Observed		
	Organic (1)	**Conventional (0)**	**Total**
Organic (1)	86	25	111
Conventional (0)	39	88	127
Total	125	113	238
Hits	68.8%	77.9%	

organic by 29.2% and 33.6%, respectively. The relationship between age and organic farming is perhaps influenced by older farmers being less aware of environmental issues; according to the estimated marginal effect for the age variable, the pass of one generation (30 years) would increase the probability of being an organic citrus farmer by around 15%. In addition, the fact that farmers that set aside part of their production for export markets are less likely to become organic might be influenced by international commercialization channels for organic citrus being less developed, due to organic citrus produce being mostly sold in local markets.

Neither union membership nor belonging to an association of either production or commercialization of citrus produce influence the decision of farmers to go organic in a statistically significant way. Taking these results together with the consideration on behalf of organic farmers of a lack of information (*i.e.,* concerning technology and commercialization channels) as the most relevant factor hindering the adoption of organic farming, might well suggest that these associations are not performing the task of providing their associates with technical advice on organic citrus farming accordingly. Finally, being a part-time farmer does not seem to influence the decision to adopt organic techniques in a statistically significant way either.

Discussion

All around the world organic food is increasing its share of total food output and receiving the support of policymakers concerned with agricultural sustainability issues. But in the case of citrus growing, one of Spain's primary agricultural exports, organic farming has only been adopted by a small minority of citrus growers to date. This is particularly the case in the region of Valencia, which usually represents three quarters of Spain's citrus exports and more than 60% of citrus production. A fair understanding of the drivers behind conversion to organic growing seems highly pertinent in order to increase the rate of adoption by conventional farmers. In this research we have tried to ascertain the factors behind the decisions to grow organic citrus fruit. Furthermore, conventional probit model estimation has been used to investigate the farmer characteristics that influence the probability of becoming an organic grower. Concerning the data, we use information from a survey of 125 organic citrus farmers in the region of Valencia, which represent 61% of the population of organic farmers, in addition to a control group of 113 conventional citrus farmers.

Organic farmers were asked to respond to specific questions regarding their motivations to go organic and, also, the main factors hindering the diffusion of organic citrus growing. Concerning the motivations driving the decision to become organic, their answers showed that environmental concerns, concern for the wellbeing of future generations, interest in producing high quality products and a willingness to reduce dependence on agrochemical products figure prominently as issues of outstanding importance. Conversely, pecuniary motivations play a less important role. It is interesting to note that only 12% of the organic producers interviewed mentioned agri-environmental subsidies as a driver of their decision to go organic, while 85% mentioned environmental concerns. This high profile of non-materialistic values is in accordance with the incipient nature of the adoption process of organic techniques of citrus growing in the region, as is frequently found in the literature focused on the characteristics of early and late adoption (Padel, 2001, 2008; Läpple & Van Rensburg, 2011).

As regards the factors that discourage the adoption of organic citrus farming techniques, the highest frequency of responses correspond to a lack of advisory services, a lack of information on commercialization channels, a lack of technical information, problems related to fertilization and a lack of skills to manage organic farming. These results indicate the critical role of enhancing farmers' technical knowledge and education and providing agricultural advisory services in order to reduce the risk implicit in shifting to organic production for conventional farmers. With regards to the lack of commercialization channels, this has also been cited by other researchers as one of the explanations for the limited expansion of organic citrus farming in the region of Valencia (Peris *et al.*, 2005), along with high production costs and insufficient information for consumers.

Regarding our results from the probit regression, we find that university education and agricultural professional training both significantly boost the probability of becoming an organic farmer. In addition, older farmers, farmers with larger farms and/or managing family farms and farmers that sell part of their production to foreign markets are less likely to adopt organic citrus farming techniques. Other variables, such as being members of associations for production or commercialization purposes, farmers' union membership and part-time farming do not appear to influence the likelihood of becoming an organic citrus farmer in a statistically significant way.

We may conclude, on the one hand, that the analysis of citrus farmers' opinions avail the position of those researchers who have stressed the role of individual ethics and social motivations when explaining changes in farmers' behavior and the preeminence granted to environmental concerns and the production of high quality produce. On the other hand, low profitability or the prospect of poor demand are not, from the point of view of farmers, the main obstacles preventing producers from making the change to organic techniques. Instead, a lack of information and underperforming advisory services play an important role. In some way it is an encouraging finding, because it points to shortcomings that can be solved by proper policy measures: successful agricultural extension should play an important role in helping to bridge the gap between conventional practices and new technologies. This role is particularly critical in the initial stages of the adoption process, when early adopters are still a minority, as is the case with citrus farmers in the region of Valencia.

Also, another important conclusion from our analysis is the key role that education and professional training play when it comes to explaining organic citrus farming. In our opinion, this result leads to an important implication for policymakers, which is the relevance of strategies based on a learning perspective as a powerful instrument capable of encouraging the adoption of organic citrus farming techniques. Initiatives linked to management programs aimed at enhancing farmers' knowledge of organic technologies and managerial abilities would be potentially useful in this sense, as well as information programs aimed at increasing farmers' environmental awareness. Furthermore, our findings as regards the importance of education and professional training programs to boost organic farming are in line with those obtained by other recent studies, which also highlight the importance of education to improve aspects such as ecological-economic efficiency or technical performance in several Spanish agricultural systems (Picazo-Tadeo *et al.*, 2011, 2012; Gómez-Limón *et al.*, 2012).

Finally, and also concerning the policy implications of our findings, we believe our results could help to improve policy design concerning support for organic citrus farming. In this sense, providing subsidies should not be considered the most efficient instrument to increase the adoption of the organic model of production. Instead, and besides correcting the structural problems of citrus farming in the region of Valencia (too small farms and a lack of full-time professional farmers, among others), a new approach must pay more attention to increasing technical training and education concerning organic farming and to provide expertise to reduce the risk of adoption. The attitudes of agricultural professionals (*i.e.*, extension officers, private consultants or researchers) may also play a very important role in helping to increase the acceptance of organic and other agricultural innovations by farmers. According to international experience, a greater acquaintance with organic farming topics and an understanding of natural resource management will positively influence the attitude of professional experts towards organic farming, making a substantial contribution to the adoption of organic techniques by farmers.

Acknowledgments

The authors acknowledge the comments received from María Rochina-Barrachina from the University of Valencia. Furthermore, the financial support received from the Spanish Ministry of Economy and Competitiveness and the European Regional Development Fund (projects AGL2010-17560-C02-02/AGRI, ECO2011-30260-C03-01 and ECO2012-32189), the Andalusian Department of Economy, Innovation and Science (projects AGR-5892 and P11-SEJ-7039) and the Generalitat Valenciana (program PROMETEO 2009/098) is gratefully acknowledged.

References

Armesto-López XA, 2008. Organic farming in Spain — Two case studies: Catalonia and Galicia. J Sustain Agr 31(4): 29-55.

Becker B, 1997. Sustainability assessment: a review of values, concepts and methodological approaches. Issues in agriculture 10. CGIAR-World Bank, Washington.

Bliss CI, 1934a. The method of probits. Science 79: 38-39.

Bliss CI, 1934b. The method of probits — A correction. Science 79: 409-410.

Burton M, Rigby D, Young T, 1999. Analysis of the determinants of adoption of organic horticultural techniques in the UK. J Agr Econ 50(1): 47-63.

Cameron AC, Trivedi PK, 2010. Microeconometrics using Stata. Stata Press, College Station, TX, USA.

Crosson PR, 1999. Sustainable agriculture. In: The RFF reader in environmental and resource management. Resources for the future (Oates WE, ed.). Washington, DC, pp: 257-262.

Domínguez-Gento A, 2007. Estudi d'un cas de conversió en la citricultura ecològica valenciana. CAECV Informa 5: 3-6 and 6: 6-9. [In Catalan].

Domínguez-Gento A, 2008. La citricultura ecológica. Servicio de Asesoramiento a los Agricultores y Ganaderos. Dirección General de Agricultura Ecológica. Consejería de Agricultura y Pesca de la Junta de Andalucía. Seville, Spain. [In Spanish].

Gómez-Limón JA, Picazo-Tadeo AJ, Reig-Martínez E, 2012. Eco-efficiency assessment of olive farms in Andalusia. Land Use Policy 29(2): 395-406.

Hansen JW, 1996. Is agricultural sustainability a useful concept? Agr Syst 50: 117-143.

Howe ChW, 1997. Dimensions of sustainability: Geographical, temporal, institutional, and psychological. Land Econ 73(4): 597-607.

Ingram J, 2008. Agronomist–farmer knowledge encounters: an analysis of knowledge exchange in the context of best management practices in England. Agr Hum Values 25(3): 405-418.

Kaufmann P, Zemeckis R, Skulskis V, Kairyte E, Stagl S, 2011. The diffusion of organic farming in Lithuania. J Sustain Agr 35: 522-549.

Koesling M, Flaten O, Lien G, 2008. Factors influencing the conversion to organic farming in Norway. Int J Agr Resour Gov Ecology 7(1/2): 78-95.

Landis, J, Koch, G, 1977. The measurement of observer agreement for categorical data. Biometrics 33: 159-174.

Läpple D, Van Rensburg T, 2011. Adoption of organic farming: Are there differences between early and late adoption? Ecol Econ 70: 1406-1414.

Lynam JK, Herdt RW, 1989. Sense and sustainability: sustainability as an objective in international agricultural research. Agr Econ 3(4): 381-398.

MARM, 2010. Estadísticas 2010 de agricultura ecológica, España. Ministerio de Medio Ambiente y Medio Rural y Marino, Madrid. [In Spanish].

Mzoughi N, 2011. Farmers adoption of integrated crop protection and organic farming: Do moral and social concerns matter? Ecol Econ 70: 1536-1545.

Padel S, 2001. Conversion to organic farming: A typical example of the diffusion of an innovation? Sociol Ruralis 41(1): 41-61.

Padel S, 2008. Values of organic producers converting at different times: results of a focus group study in five European countries. Int J Agr Resour Gov Ecology 7(1/2): 63-77.

Parra-López C, De Haro-Giménez T, Calatrava-Requena J, 2007. Diffusion and adoption of organic farming in the Southern Spanish olives groves. J Sustain Agr 30(1): 105-151.

Peris EM, Juliá JF, 2006. Production costs of the organic Clementine crop in the region of Valencia (Spain). Span J Agric Res 4(1): 17-25.

Peris EM, Juliá JF, Balasch S, 2005. Estudio de las diferencias de costes de producción del cultivo de naranjo convencional, ecológico e integrado en la Comunidad Valenciana mediante el análisis factorial discriminante. Econ Agrar Recurs Nat 5(10): 69-87. [In Spanish].

Picazo-Tadeo AJ, Reig-Martínez E, 2005. Calculating shadow wages for family labour in agriculture: An analysis for Spanish citrus fruit farms. Cahiers d'Economie et Sociologie Rurales 75: 6-20.

Picazo-Tadeo AJ, Reig-Martínez E, 2006. Outsourcing and efficiency: the case of Spanish citrus farming. Agr Econ 35(2): 213-222.

Picazo-Tadeo AJ, Reig-Martínez E, Gómez-Limón JA, 2011. Assessing farming eco-efficiency: A data envelopment analysis approach. J Environ Manage 92(4): 1154-1164.

Picazo-Tadeo AJ, Beltrán-Esteve M, Gómez-Limón JA, 2012. Assessing eco-efficiency with directional distance functions. Eur J Oper Res 220: 798-809.

Porcuna JL, Gaude MI, Castejón P, Domínguez A, 2010. Guía de agricultura ecológica de cítricos. Proyecto Mayas. Federación de Cooperativas Agrarias de la Comunidad Valenciana, Valencia, Spain. [In Spanish].

Pretty J, 2008. Agricultural sustainability: concepts, principles and evidence. Philos Trans R Soc B Biol Sci 363: 447-465.

Rao NH, Rogers PP, 2006. Assessment of agricultural sustainability. Curr Sci 91(4): 439-448.

Rigby D, Young T, Burton M, 2001. The development and prospects for organic farming in the UK. Food Policy 26(6): 599-613.

Rogers EM, 1983. Diffusion of innovation. The Free Press, NY.

Stolze M, Lampkin N, 2009. Policy for organic farming: rationale and concepts. Food Policy 34: 237-244.

Wheeler SA, 2011. What influences agricultural professionals' views towards organic agriculture? Ecol Econ 65: 145-154.

WCED, 1987. Our common future. World Commission on Environment and Development, Oxford University Press. Oxford, UK.