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Mercedes Beltrán-Esteve
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Ernest Reig-Martínez

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Departamento de Estructura Económica (Economía Aplicada II), Facultad de Economía, Universitat de València
Avda dels Tarongers, s/n, 46022 – Valencia, Spain
Phone +34 96 382 83 49 / Fax +34 96 382 83 54
http://www.estructuraeconomica.es
e-mail: investigacion.estructura@uv.es

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

Mercedes Beltrán-Esteve, Andrés J. Picazo-Tadeo and Ernest Reig-Martínez*

Departamento de Economía Aplicada II. Universidad de Valencia.
Campus de Tarongers. 46022, Valencia. Spain.

* Corresponding author. Telephone: ++ 34 963 828 339; email: ernest.reig@uv.es

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 of a sample of conventional and organic citrus farmers obtained from a survey specifically designed for the purpose of this research. 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 farms of greater size 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 improve farmers' technical training and education concerning organic farming.

ADDITIONAL KEYWORDS: Citrus farming; organic *versus* conventional production; probit estimation; education and professional training; Spain.

JEL CLASSIFICATION: C25; Q01; Q12; Q57.

1. Introduction

Agricultural policies in developed countries are evolving in the direction of promoting more ecologically-friendly farming techniques. Concern for food safety and the spread of non-materialistic values are driving consumers towards organic products. While mainstream farming still relies on the intensive use of chemical inputs for fertilization and crop protection, new alternatives are being developed to prevent environmental damages arising from conventional agricultural practices and their negative impacts on consumer and producer health. The European Union has established that environmental protection requirements '*must be integrated into the definition and implementation of the Union's policies and activities, in particular with a view to promoting sustainable development*'. (Treaty on the Functioning of the European Union, article 11). At the same time, European rural development policy (Council Regulation 1698/2005) aims to encourage farmers to serve society's goals by introducing or continuing to apply agricultural production methods deemed compatible with the protection and improvement of the environment. Also, recent reforms of the Common Agricultural Policy have shifted policy emphasis from price support to market-orientation and the supply of quality products, which is likely to stimulate the development of a market in organic produce.

Spanish agriculture has not remained untouched by these changes. Nevertheless, citrus fruit, one of the country's most valuable crops, both in terms of monetary value of production and exports, still remains massively focused on conventional techniques. Going organic may be a positive step, not only in terms of enhancing agricultural sustainability, but also in order to use price premiums to overcome the disadvantages of working with higher production costs than those of other competitors, in particular in the Southern Mediterranean basin. Efficient policies to favor the transition to organic agriculture require a fair understanding of the elements that characterize organic farmers and distinguish them from conventional farmers specializing in the same crop or livestock. Moreover, a better knowledge of farmers' motivations is important, because the reasons behind farmers adopting ecologically-friendly practices are not always well understood. Economic concerns play an important role, but farmers' behavior may also change for moral reasons or social concerns.

The aim of this paper is to give new insight into the characteristics of organic citrus farmers in Spain with regards to conventional ones, and also to enquire about the motivations that inspire those farmers that have become organic growers. A survey of citrus growers in the Eastern Spanish region of Valencia has been undertaken by the authors to meet the specific needs of this research, obtaining a balanced sample of both conventional and organic farmers. Then, a conventional probit regression model is estimated to ascertain the main determinants of the adoption of an organic *versus* a conventional farming system. In our view, the results will help professional organizations and policymakers better understand the driving forces behind the expansion of organic agriculture in the citrus growing sector and help policymakers design better strategies to promote sustainable agriculture.

Following this Introduction, Section 2 discusses the concept of sustainable agriculture in connection with organic farming and reviews the literature on the diffusion of organic agriculture. Section 3 describes the technical aspects of citrus farming in the region of Valencia. Section 4 describes the data and explains the methodology. Section 5 presents the results and highlights some policy implications, while a final Section summarizes and concludes.

2. Sustainable agriculture and organic farming

Organic farming must be necessarily referred to a broader and relatively abstract framework that revolves around the concept of sustainable agriculture. But sustainable agriculture means different things to different people, including farmers and professional agriculturalist experts (Lynam and Herdt, 1989, Hansen, 1996, Becker, 1997, Rao and Rogers, 2006). On the one hand, one interpretation of sustainable agriculture focuses on technological issues, is prone to emphasize the convenience of adopting techniques that reduce reliance on non-renewable or environmentally harmful inputs, and pays special attention to the particular characteristics of the settings where farming takes place. On the other hand, sustainability is more concerned with those aspects that go beyond specific agricultural systems, and stresses the shortcomings of simple productivity criteria when judging the social value of farming, the importance of externalities –both positive and negative– that arise from crop cultivation and rearing livestock, and inter and intra-generational issues.

A hierarchical view of agriculture may embrace both interpretations, as appropriate to different levels of analysis, because sustainability must reflect the relevance of agronomic constraints at field level, microeconomic constraints at farm level, ecological considerations at watershed or landscape level and adopt a macroeconomic approach when dealing with topics at national or international level (i.e., food security). As the analysis progresses towards the top of the hierarchy, additional degrees of freedom are obtained in the achievement of sustainability (Howe, 1997). Thus, agricultural systems defined at a higher level (i.e., agricultural region *versus* individual farm) are more resilient, because they have a greater probability of survival when production conditions worsen.

Some authors have adopted definitions of a sustainable agricultural system inspired by the Brundtland Report (WCED, 1987), which points to its ability 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), namely: i) integrate biological and ecological processes (i.e., nitrogen fixation and soil regeneration) into food production processes; ii) minimize the use of non-renewable inputs that cause harm to the environment or that involve health risks for farmers and consumers; iii) make productive use of the knowledge and skills of farmers, substituting costly external inputs with human capital and iv) make productive use of people's collective capacities to work together towards solving common agricultural and natural resource problems.

In connection with these basic principles, some practical consequences also arise: technologies and practices must be locally adapted and fitted into place, which implies that there are likely many pathways towards agricultural sustainability. Accordingly, it is wrong to assume that agricultural sustainability always implies extensification, in the sense of using more land to produce the same amount of food. Actually, it is a matter of changing some factors of production for others (e.g., chemical fertilizers to nitrogen-fixing legumes) and making the best use of natural, social and human capital assets and technologies, with the meaning of a type of intensification that is sustainable because it minimizes or eliminates harm to the environment (Pretty, 2008).

Unsustainable agricultural practices may disrupt the ability of ecosystems to provide goods and services. There is currently a wide recognition that society receives many benefits, grouped under the name of ecosystem services, from both natural and managed ecosystems (i.e., agricultural systems). Forest land cover can minimize flooding by slowing rain flows and store atmospheric carbon dioxide. Mangrove ecosystems play an important role in storm protection on tropical coastlines. Wetlands are important in the protection of biodiversity and in the water cycle, filtering and purifying surface waters and allowing aquifers to recharge. Furthermore, agricultural systems not only provide food, fiber and fuel, but also a range of non-market services: farmers are the main managers of terrestrial usable lands and are well placed to provide or deny ecosystem services to the rest of society. Positive contributions include the supply of all three major categories of ecosystem services (i.e., provisioning, regulating and cultural services), with pollination, agronomic management leading to the maintenance of soil fertility, the retention of soil carbon, and keeping alive the cultural heritage of rural lifestyles, as well known examples (Swinton et al., 2007, Zhang et al., 2007).

On the negative side, it is also true that some agricultural practices can reduce the ability of ecosystems to provide goods and services. Intensive use of fertilizers can increase nutrients and toxins in groundwater and surface waters and pesticides may lead to increases in pest outbreaks by leading certain species to develop genetic resistance to specific pesticide compounds. Pesticides can also seriously damage human health. Competition for water may lead to crop irrigation causing the disappearance of natural wetlands. And high-density animal production can increase the emergence of new, often antibiotic-resistant diseases and contribute to the pollution of air, groundwater, and surface water because of the massive presence of animal wastes. In addition, the use of heavy machinery to prepare land, combined with the absence of plant cover during the rainy season cause erosion on steep slopes and the loss of fertile soil (Tilman et al., 2002). The external costs and benefits of modern agriculture raise important policy issues concerning public support to farmers for the multiple public benefits they provide, as agriculture is deemed as inherently multifunctional, and also concerning the most efficient ways to encourage the right behavioral changes with regards to negative externalities (Pretty et al. 2001).

Agricultural sustainability must face a double challenge: correcting negative impacts on the environment and making sure that enough food is available to cover the growing needs of a more populated and affluent planet. FAO (2010) has estimated that the total number of undernourished people in the world amounted to 1023 million in 2009, a figure that would fall to 925 million in 2010. This means that there is still a very large number of people who suffer from hunger and in many countries child mortality rates reflect a poor diet. This situation is more a consequence of the unequal distribution of worldwide purchasing power than of the inadequacy of global food production, but there are growing concerns with regards to the ability to maintain past trends in worldwide agricultural productivity. A slowdown in rates of yield growth for maize, rice, wheat and soybean crops has been experienced in 1990-2007 in comparison with 1961 to 1990 and global land productivity has also grown at a slower pace over the same period (Alston et al., 2009). But a possible increase in the food supply is not enough to combat hunger and poverty. Poor farmers in developing countries need to gain access to low-cost technologies that would not only allow them to increase local farm output and raise their income, but also to make the best use of their land, water and other natural assets without degrading them. Some novel initiatives have emerged since the 1990s and their assessment has shown that it is possible to increase food crop productivity while at the same time increasing water use efficiency and carbon sequestration and reducing pesticide use. A variety of resource-conserving technologies and practices, like integrated pest management, conservation tillage, aquaculture or livestock integration in farming systems, have been tried in projects undertaken in 57 developing countries with good results (Pretty et al., 2006).

Organic farming may be described as the type of farming whose main aim is to create a sustainable agricultural production system. Sustainability is used here in the broadest sense of the term, including environmental, economic and social aspects. 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, whether chemical or organic.[1] Another characteristic of organic agriculture, in practice, is the willingness of farmers and other operators to contribute to the development of a special market for agricultural produce, able to attract premiums from the concerned consumer. Financial rewards are thus regarded as an integral part of the motivations behind organic farming. Organic farming has been gaining strength over the last few decades. Current estimates indicate there are 1.8 million organic farmers around the world, with the organic farming movement present in 160 countries, 24 of which devote more than 5% of their farmland to organic farming (IFOAM, 2011).

This new vision of farming gained momentum in Europe when governments began to provide support. The European Union addressed organic farming for the first time comprehensively through Council Regulation (EC) 2092/1991. Council Regulation (EC) 834/2007 established the legal framework for the production, distribution and labeling of organic produce. Later on, Commission Regulation (EC) 889/2008 laid down detailed rules for the implementation of the norms previously established for the production, distribution and control of farm organic production. Other specific and complementary European legislation exists to deal with specific topics related to organic farming (i.e. imports of organic products from third countries). National and regional legislation (in the Spanish case) has followed suit in order to create a framework to monitor and certify the operations of organic farmers, food manufacturers and traders.

Organic farming can be summarized as '*an approach to agriculture that emphasizes environmental protection, animal welfare, food quality and health, sustainable resource use and social justice objectives, and which utilizes the market to help support these objectives and compensate for the internalization of externalities*' (Stolze and Lampkin, 2009, p. 237). The aim is to strike a balance between delivering societal benefits through organic land management and responding to specific consumer demands in the organic marketplace. Public policy towards organic farming may establish incentives that reward the supply of public goods by organic farmers, while price premiums may compensate for the supply of specific attributes of organic produce that are particularly appreciated by consumers.

Ecological or organic farming has been deemed defective in connection with its ability to satisfy rising global food needs. The more relevant criticisms leveled at organic farming with

[1] Terminology changes from country to country. Here we follow the more common use in Anglo-Saxon countries of 'organic agriculture', although in some places the terms 'ecological' or 'biological' are preferred.

regards to this topic have to do with the assumed lower yields of organic versus conventional farming, and also the lack of enough organically acceptable fertilizers in the face of growing food demand. Both assumptions would involve organic farm systems using more land to produce food than conventional systems, thus offsetting other environmental advantages of adopting organic farming techniques. However, the yield superiority of conventional farming appears to be true only in the developed world –and by small margins–, while in most poor countries the transition from low-intensity traditional methods of farming to organic farming would substantially raise average yields. Moreover, the use of green manure and rotation methods could contribute to nitrogen fixation in such a way that no additional land area would be required to obtain enough biologically available nitrogen to replace the current use of synthetic fertilizers (Badgley et al., 2007).

2.1. The diffusion of organic farming and the characteristics of adopters

Some researchers have analysed the diffusion of organic farming within a global pattern of adoption/diffusion of innovations, considering it as a particular type of innovation. Organic farming has been conceptualized as an attempt to create a sustainable agricultural production system –reflecting a reliance on self-regulating biological processes and renewable processes– and organic farmers have been treated as innovators or early adopters. According to innovation theory, innovators are generally better educated than later adopters, have larger-sized farms and have 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. And the evidence is not conclusive concerning differences in farm size. On the basis of the general adoption/diffusion model of agricultural innovations, the differences between the first organic and conventional farmers can be interpreted as differences between innovators and later adopters. In this light, the fact that people converting more recently to organic farming display some motivations and characteristics that are not the same as those displayed by the pioneers of the organic movement cannot be seen as a shortcoming of those currently converting. Instead, it is a typical feature of any diffusion process, with late adopters behaving differently to innovators (Padel, 2001).

A number of authors have conducted empirical research into farmers' decisions to convert to organic farming in a variety of contexts, describing in the process some characteristics of organic farmers. In the United Kingdom, using a sample of 237 horticultural producers, organic producers were found to be younger than conventional farmers and to have started to work in agriculture later. They were also prone to rely 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 female, concerned with environmental issues, was a member of a countryside or environmental organization, tried to maximize the proportion of own-consumption of farm produce, 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). A cross-sectional survey of farmers in 2003 in Norway noted that organic farmers had three years less farming experience than average conventional farmers and more agricultural education. They were also more likely to have university or college education. As a group, 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. In second and third place they ranked *producing high quality foods* and *reliable and stable income*, while the other groups ranked these two goals first and second, respectively. For potential converters to organic farming, financial motives such as *profitability* and receiving *organic farming payments* were more important than for established organic producers (Koesling et al., 2008). But not all research findings support the same conclusions.

A focus group study of the values of organic producers entering the sector in Austria, Italy, the Netherlands, the United Kingdom and Switzerland did not reveal substantial differences concerning the motives of earlier and later converters to organic farming, except that newly converted farmers appeared more concerned with the need to keep up with general developments in agriculture, in relation to environmental conservation and animal welfare, and to meet consumer expectations. For established producers, aspects like closed production cycles and systems health appeared to be especially important. It was also observed that farmers had economic or financial motives for converting to organic farming in specific geographical regions (i.e. mountain areas), indicating the relevance of external conditions, which may be a more important factor than the timespan since conversion when it comes to explaining different farmers' attitudes and motives (Padel, 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. Some researchers have shown that non-economic concerns are important drivers of farmers' behavior, besides purely monetary considerations (Rigby et al., 2001). A recent survey of fruit-growers and vegetable producers located in the Provence-Alpes-Côte d’Azur Region, in France, have shed light on farmers reasons for selecting alternative crop protection methods –classified into conventional, integrated and organic methods. Moral, social and economic concerns matter differently according to the protection method adopted. While there is no significant difference between conventional farmers and those using integrated crop protection, the responses given by organic farmers differ significantly from both. Moral concerns, like *doing the right thing* and *not feeling guilty about their own choice* received significantly more attention from organic farmers, who assigned less importance to economic concerns, like reducing production costs and risks, compared to the rest of farmers. This and other studies have lent support to the idea that moral and social concerns matter and that economic incentives are not enough for an efficient promotion of organic farming methods: making the commitment of individual farmers to ecologically-friendly practices visible to others is also important (Mzoughi, 2011).

For some countries, the late development of the market for organic produce and the strong link from its inception to the implementation of supporting agricultural policies have played a role in farmers’ motives for adoption. This seems to be the case in Lithuania, where the organic movement took-off after the Common Agricultural Policy started to subsidize organic farming. Research on the diffusion of organic farming in this country has found that financial support is the primary reason for increasing diffusion. Main motivations also include farmers’ judgment concerning their ability to manage an organic farm effectively and the expectations of the effects of subsidies on land and land-rent prices. A survey of 210 farmers also discovered a low uptake of extension services and particularly a low availability of organic farming specific advisory services, which were hampering the rate of adoption. Adopters were generally younger, worked in the arable land sector and had larger holdings than non-adopters (Kaufmann et al., 2011).

In Thailand, a developing country, the adoption of organic vegetable farming was studied on the basis of a sample of 172 vegetable farmers. Results showed that female farmers played a leading role in growing organic vegetables and that satisfaction with the price of organic produce and participation in motivational and capacity building programs exerted a positive influence. The extent of adoption of organic farming by individual farmers also depended on several factors, like the amount of organic fertilizers produced by the farmers themselves and the perceived harmful effects of non-organic pesticides. Experience in growing vegetables was in this case a positive influence on going organic. Difficulties reaching the market in the capital city, Bangkok, where organic vegetables fetched an important price premium, was a discouraging factor for farmers in the area of study (Tapa and Rattanasuteerakul, 2011).

In Spain, the development of organic farming gained speed in the mid-nineties, when it became possible to claim subsidies from the agri-environmental measures established by European Common Agricultural Policy. Given the extraordinary variety of farming specialties and operator characteristics in the different regions, most Spanish studies have a distinctly regional emphasis. On the basis of personal interviews, four types of organic farmers were identified in the regions of Catalonia and Galicia (Armesto-López, 2008), namely, the ecologically aware (the youngest organic farmers, endowed with a high sense of environmental and social responsibility), the pragmatic (financially profitable middle age producers, with a mix of financial and environmental motivations), the *bonus hunter* and the older, pre-productivist farmers (operating small undercapitalized farms, which automatically comply with the minimum requirements needed to be declared organic). 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). Problems related to product marketing and lower profits were mentioned as the main difficulties hampering the development of organic farming in both regions.

Andalusia is the region in Spain with the highest percentage of agricultural surface area devoted to organic produce (more than 4%). Olive farming is the main source of income from agriculture in the rural areas of the region, but has caused serious environmental problems. It has been considered that adopting organic techniques may contribute to the sustainability of olive farming in the region. Extensive research has been undertaken concerning the adoption of organic farming in seven homogenous olive-growing areas, based on interviews conducted with a total of 322 olive farmers, both organic and conventional (Parra-López et al., 2008). The main findings can be summarized as follows. Interpersonal contacts within each of the areas studied are very important in the diffusion of organic farming, highlighting the information-intensive nature of this process, innovativeness is greater among farmers from traditional and extensive olive-growing areas in Andalusia, and early adopters have similar socioeconomic characteristics (i.e., age, formal education or specific agricultural training) to late adopters. Nevertheless, early adopters are more aware of the health and environmental aspects of production, have less risk aversion, are more dependent on informal sources of information, have less experience in agriculture and their earnings are more dependent on agriculture. Conversely, later adopters have a less-favorable image of the economic advantages of organic farming. Another finding is that the highest rate of adoption corresponds to the most marginal and underprivileged farming zones.

3. Organic citrus farming in Spain: the case of the Valencian region

Organic citrus farming has some distinctive technical aspects that are different from those in conventional citrus farming. Organic citrus orchards use compost manure (10 to 20 tons per hectare per year), which is then supplemented with complex organic materials such as animal and plant remains, algae extracts, food industry products, guano etc. Green manure crops of rapid growth, which are cut and buried in the place where they have grown, are able to contribute large annual quantities of humus and nutrients. The soil incorporation of pruning from trees, after those remains have been crushed, also helps to improve soil quality, reduces the need for crop fertilizers and contributes to reducing CO_2 emissions.

An organic citrus orchard maintains biodiversity through ground cover, of which the most interesting plants are the alfalfa, for their positive relationship with fertilization, and wild grasses, because of their relationship with wildlife. Biodiversity is also enhanced by using hedgerows, which prevent wind damage and provide a home and support for populations of beneficial insects and birds. They may be made up of fruit trees, Mediterranean shrubs, decorative plants and others. A high level of plant biodiversity fosters a correspondingly diverse population of microbial and insect species, which contribute to fighting pests, but when natural predators are not enough to exert biological pest control, then it is permissible to carry out treatments with mineral oil or paraffin.

Pruning is performed in a similar way to that in traditional citrus farming, but with some differences concerning waste disposal. In organic citrus farming, pruning remains are crushed and left as waste compost on the surface, thereby restoring a lot of nutrients to the soil. In contrast, burning pruning remains causes large losses of organic matter and increases carbon dioxide emissions. It is also convenient to use traditional techniques such as scratching, which consists of making a shallow circular cut on the main branches. The purpose is to block the sap in the branches that are above the cut, favoring the fruit set and fattening. With regards to irrigation, it has been remarked that organic citrus farming can make a better use of limited water resources because organic plots of land have a greater proportion of humus and organic matter in the soil, which helps to retain moisture better. In turn, it makes it possible to extend the interval between waterings. Localized irrigation is the most convenient watering system, but makes mechanization more difficult. Beyond this short summary, a detailed description of the technical aspects of organic citrus farming may be found in Porcuna et al. (2010) and Domínguez-Gento (2008).

Organic citrus farming currently represents a small proportion of total farmland devoted to citrus production in the region of Valencia. According to official statistics (MARM, 2010), the surface area devoted to citrus farming in 2010 represented a total of 178,361 hectares, with a production of 4.18 million tons (IVEX, 2011), which represented 57% of total Spanish output in that year. Organic citrus groves were estimated to cover only 1,004 hectares in the region.

Some reasons have been given to explain the slow diffusion of organic farming concerning this crop, 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 and 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. Organic orchards are also substantially more labor-demanding than conventional ones: weeds must be removed mechanically, instead of using chemical products, more labor is required to apply organic manure than conventional fertilization and mulching formation from crushing ground wood after pruning also consumes labor. Besides those tasks, organic farmers must spend time keeping hedgerows in good condition and cultivate plant cover. Savings in expenditures related to herbicides, fungicides and insecticides do not offset these higher labor costs.

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 and Juliá, 2006; Domínguez-Gento, 2007). Conversely, the market prices of organic citrus produce are considerably higher than for conventional produce. These and also other 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.

4. Data and methodology

4.1. Data, variables and sample

The information used in this research comes from a survey specifically designed and conducted by the authors in the framework of a research project aimed at analysing both the economic and environmental performance of citrus farming in the Spanish region of Valencia. The survey involved personal interviews in 2010 and included 282 questionnaires, 153 of them being completed by organic citrus farmers and the remaining 129 by conventional citrus farmers. Organic citrus farmers registered on the Census of Organic Citrus Farming of the Department of Agriculture of the Valencian regional government were interviewed, whereas conventional farmers were randomly selected by quota sampling the population as a whole by citrus farming area. This guarantees that the sample is representative both at regional level and at the level of the different citrus production areas that exist in the region of Valencia. Using these questionnaires as a basis, some outliers and observations with missing data were deleted, which led to a final sample of 238 citrus farms, 125 of which (52.5%) were organic farming systems and 113 (47.5%) conventional systems. Table 2a describes the variables used in this research to explain the decision to become an organic citrus farmer and presents some descriptive statistics.

The variable *gender* is a qualitative variable that takes a value of 1 in the case of farms managed by a male and 0 if the manager is female, while the variable *age* indicates the age of the manager. The ages of the farmers in the sample range from 20 to 87 years old, with an average age of 50.2 years, and aside from the under-30s and over-80s, which represent 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 hectares. *University education* and *professional training in agriculture* are both qualitative variables that take a value of 1 if the farm manager has completed university studies or he/she has vocational training in agriculture, respectively, and 0 otherwise. As can be seen, almost 32 of every 100 farmers in the sample have university studies, whereas only 4.6% have professional training in agriculture. The variable *family farm* is also a dummy variable that assigns a value of 1 to farms which are family businesses, in opposition to cooperatives and other legal forms for citrus farms. A 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 dummies that take a value of 1 if the manager of the farm is a member of the Unió de Llauradors i Ramaders, AVA-ASAJA or other farmers' unions in the Valencian region (42.4% of farmers in the sample), an association of producers (29.8%) or a commercialization association (65.1%), respectively, and 0 if they are not. 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 and Reig-Martinez, 2005; 2006).

Beyond the averages commented on in previous paragraphs, differences between organic and conventional citrus farms for some variables are important, as shown by Table 2b. 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 hectares) than conventional farms (3.35 hectares). Moreover, 43.2% of organic farmers in the sample have attained university studies, while only 19.5% of conventional farmers have reached this level of education; likewise, 7.2% of organic citrus farmers have professional training in agriculture against 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.

4.2. A brief note on the methodology

In order to investigate into the determinants of the decision of a citrus farmer going organic, in this paper we use a standard probit regression model (Bliss, 1934a,b). The result of the decision convert to organic farming is represented by the observed binary variable *Organic*, which takes a value 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 thus 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:

$$Organic = \begin{bmatrix} 1 \;\; if\, Organic^* > 0 \\ 0 \;\; if\, Organic^* \leq 0 \end{bmatrix} \tag{1}$$

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 | $X_{Organic}$) = $\alpha X_{Organic}$, α being a vector of unknown regression parameters. Considering the variables used in this research to explain the decision of becoming an organic citrus farmer, which are described in Section 4.1, this equation can be linearly stated as:

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

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

5. Results, discussion and policy implications

Before commenting on the results of our probit model estimation, let us briefly expound the reasons that Valencian citrus farmers claim to be the most important when they decide to change from conventional to organic citrus farming. This can be done using the rich information included in the survey conducted to perform this research. In addition to the information about the variables described in Section 4.1, organic citrus farmers interviewed in the 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 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%), the concern about future generations (84.8%), the interest in producing products of high quality (84.8%) as well as reducing the dependence on agrochemical products (81.6%) are of outstanding 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 of 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. Citrus farmers' opinions thus avail the position of those researchers who have stressed the role of individual ethics and social motivations when explaining changes in farmers' behavior (Rigby et al., 2001, Carlsson et al., 2007, Mzoughi, 2011). It is also interesting to note that these results coincide with those of Koesling et al. (2008) in regard to the preeminence granted to environmental concerns and the production of high quality produce. In contrast, low profitability or the prospect of poor demand do not represent, 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 plays an important role in helping to bridge the gap between conventional practices and new technologies. This is particularly critical in the initial stages of the adoption process, when early adopters are still a minority (Läpple et al., 2011), as is the case with citrus farmers in the region of Valencia.

Let us now discuss the results from our probit estimation regarding the determinants of the decision to become an organic citrus farmer. Equation (2) has been estimated by maximum-likelihood using the sample of 238 Spanish citrus farmers described in Section 4.1 and Stata 12 software (see Cameron and Trivedi, 2010 for details on the estimation procedure); the results for the parameters of interest are displayed in Table 3. 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.

The equation of the determinants of the decision to adopt organic production techniques is globally significant according to the results for the LR test (the p-value is negligible). Furthermore, with a pseudo-R^2 of 0.159 the goodness of fit, albeit not particularly high, is in line with other 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 4, it is a little higher for conventional farmers (77.9%) than for organic farmers (68.8%). 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 marginal effects displayed in the last column of Table 3.

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 organic by 29% and 33%, respectively. The relationship between age and organic farming is perhaps influenced by older farmers being less aware of environmental issues. In addition, the fact that farmers that devote part of their production to export markets are less likely to become organic might be influenced by international commercialization channels for organic citrus being less developed, due to being mostly devoted to local markets.

Neither union membership nor belonging to an association of either production or commercialization of citrus 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, the feature of being a part-time farmer does not seem to influence the decision to adopt organic techniques in a statistically significant way either.

In summary, one of the foremost conclusions 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 (González and Cárcaba, 2004) 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 (Ingram, 2008). 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; Gómez-Limón et al., 2012; Picazo-Tadeo et al., 2012).

6. Summary and conclusions

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 113 conventional and 125 organic citrus farmers in the region of Valencia specifically designed for the purpose of this research.

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 et al., 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 fertility and a lack of skills to manage organic farming. These results indicate the critical issue 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.

Concerning our results for the probit regression, we find on the one hand that university education and agricultural professional training both significantly boost the probability of becoming an organic farmer. On the other hand, 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 being an organic citrus farmer in a statistically significant way.

Finally, and 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 uptake 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, or in discouraging them if adopting a negative perspective. 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 (Wheeler, 2008), making a substantial contribution to the uptake of organic techniques by farmers.

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References

Alston JM, Beddow JM, Pardey PG, 2009. Agricultural research, productivity and food prices in the long run. Science 325: 1209-1210.

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

Badgley C, Moghtader J, Quintero E, Zakem E, Chappell MJ, Avilés-Vázquez K, Samulon A, Perfecto I, 2007. Organic agriculture and the global food supply. Renew Agr Food Syst 22(2): 86-108.

Becker B, 1997. Sustainability assessment: a review of values, concepts and methodological approaches, issues in agriculture. 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. College Station, TX: Stata Press.

Carlsson F, Khanh-Nam P, Linde-Rahr M, Martinsson P, 2007. Are Vietnamese farmers concerned with their relative position in society? J Dev Stud 43(7): 1177-1188.

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].

FAO, 2010. The state of food insecurity in the world 2010. Addressing food insecurity in protracted crisis. Food and Agriculture Organization of the United Nations. Rome.

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.

González E, Cárcaba A, 2004. Efficiency improvement through learning. Int J Technol Manage 27(6/7): 628-638.

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.

IFOAM, 2011. One earth, many gifts. 2010 Annual Report. International Federation of Organic Agriculture Movements. Bonn, Germany.

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.

Instituto Valenciano de la Exportación (IVEX), 2011. Cítricos de la Comunidad Valenciana. Valencia, Spain. [In Spanish].

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.

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.

Ministerio de Medio Ambiente y Medio Rural y Marino (MARM), 2010. Estadísticas 2010 de agricultura ecológica. España. Madrid, Spain. [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. Economía Agraria y Recursos Naturales 5(10): 69-87. [In Spanish].

Picazo-Tadeo AJ, Beltrán-Esteve M, Gómez-Limón JA, 2012. Assessing eco-efficiency with directional distance functions. Eur J Oper Res, in press; doi: 10.1016/j.ejor.2012.02.025.

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.

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. Philosophical Transactions of the Royal Society 363: 447-465.

Pretty J, Brett C, Gee D. Hine R, Mason C, Morison J, Rayment M, van der Bijl G, Dobbs T, 2001. Policy challenges and priorities for internalizing the externalities of modern agriculture. J Environ Plan Manage 44(2): 263-283.

Pretty J, Noble AD, Bossio D, Dixon J. Hine RE, Penning de Vries FW, Morison JI, 2006. Resource-conserving agriculture increases yields in developing countries. Environ Sci Technol 40(4), 1114-1119.

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. New York: The Free Press.

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

Swinton SM, Lupi F, Robertson G, Hamilton SK, 2007. Ecosystem services and agriculture: Cultivating agricultural ecosystems for diverse benefits. Ecol Econ 64(2): 245-252.

Thapa GB, Rattanasuteerakul K, 2011. Adoption and extent of organic vegetable farming in Mahasarakham province, Thailand. Appl Geogr 31: 201-209.

Tilman D, Cassman KG, Matson PA, Naylor R, Polasky S, 2002. Agricultural sustainability and intensive production practices. Nature 418, 8 August: 671-676.

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

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

Zhang W, Ricketts TH, Kremen C, Carney K, Swinton SM, 2007. Ecosystems services and dis-services to agriculture. Ecol Econ 64(2): 253-260.

Tables and Figures

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

Variable	Organic		Conventional	
	Mean	Standard deviation	Mean	Standard deviation
Labor intensity (Hours of labor/ha)	203.9	154.2	162.8	116.9
Average yield (Tons/ha)				
Oranges	19,175	11,665	33,805	10,248
Mandarin oranges	15,668	9,433	32,405	11,193
Average price (€/kg)				
Oranges	0.46	1.47	0.16	0.07
Mandarin oranges	0.40	0.22	0.24	0.12
Average income (€/ha)	5,933	5,143	6,820	4,916

Table 2a
Sample description

Variable	Mean [a]	Standard deviation	Minimum	Maximum
Organic (1=organic; 0=conventional)	0.525	-	0	1
Gender (1=male; 0=female)	0.933	-	0	1
Age (years)	50.6	13.0	20	87
Farm size (ha)	2.79	5.29	0.10	62.17
University education (1=yes; 0=no)	0.319	-	0	1
Professional training in agriculture (1=yes; 0=no)	0.046	-	0	1
Family farm (1=yes; 0=no)	0.916	-	0	1
Export to foreign markets (1=yes; 0=no)	0.845	-	0	1
Union membership (1=yes; 0=no)	0.424	-	0	1
Producers association membership (1=yes; 0=no)	0.298	-	0	1
Commercialization association membership (1=yes; 0=no)	0.651	-	0	1
Off-farm work (1=yes; 0=no)	0.819	-	0	1

[a] The mean for the qualitative variables represents the percentage of cases with value 1.

Table 2b
Sample description: organic *versus* conventional

Variable	Organic		Conventional	
	Mean [a]	Standard deviation	Mean [a]	Standard deviation
Gender (1=male; 0=female)	0.936	-	0.929	-
Age (years)	47.9	12.7	53.5	12.6
Farm size (ha)	2.28	3.33	3.35	6.81
University education (1=yes; 0=no)	0.432	-	0.195	-
Professional training in agriculture (1=yes; 0=no)	0.072	-	0.018	-
Family farm (1=yes; 0=no)	0.888	-	0.947	-
Export to foreign markets (1=yes; 0=no)	0.752	-	0.947	-
Union membership (1=yes; 0=no)	0.384	-	0.469	-
Producers association membership (1=yes; 0=no)	0.304	-	0.292	-
Commercialization association membership (1=yes; 0=no)	0.640	-	0.664	-
Off-farm work (1=yes; 0=no)	0.832	-	0.805	-

[a] The mean for the qualitative variables represents the percentage of cases with value 1.

Table 3
Probit estimation on the determinants of 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.

Table 4
Determinants of the production system: Probit prediction power

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

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

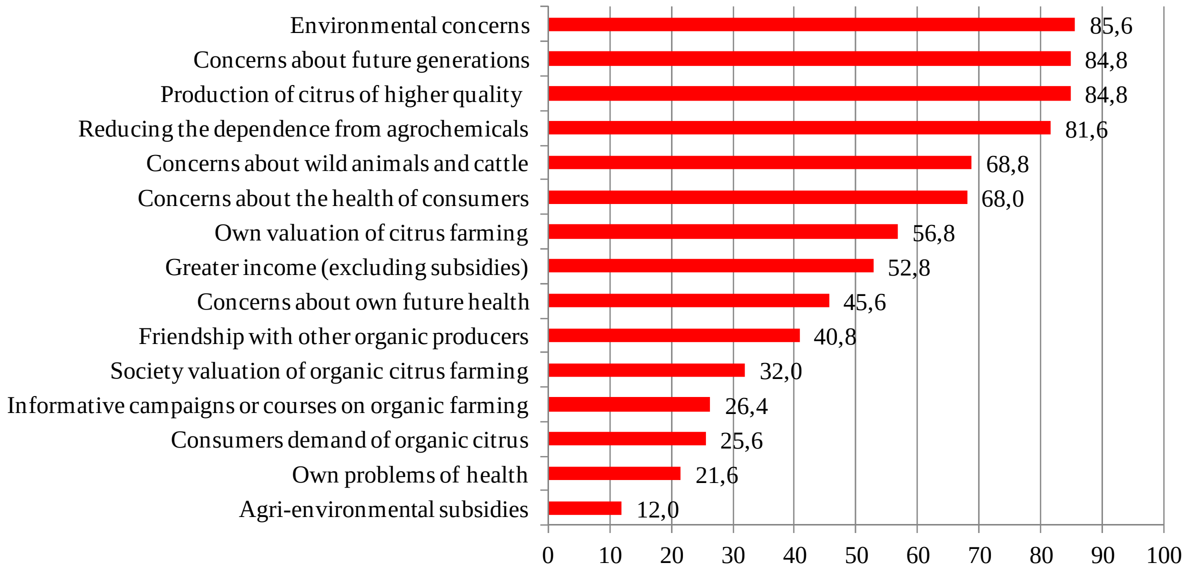

Figure 2
Obstacles to the practice of citrus organic farming (frequency of responses in %)