Farmers adoption of integrated crop protection and organic farming: Do moral and social concerns matter?

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Abstract: We investigate empirically the role of moral and social concerns in farmers' decision to adopt integrated crop protection (IP) and organic farming (OF). A survey questionnaire has been sent to 1286 fruit-growers and vegetable producers located in the French areas of *Alpes de Haute Provence*, *Hautes-Alpes* and *Vaucluse*. Analysis of individual responses (N=243) shows that, although economic concerns play a strong role, a significant number of respondents give high importance to moral and social ones. We also examine how these considerations matter according to different crop protection strategies, that is, conventional farming, IP and OF. Using a multinomial logistic regression, we find that (1) social concerns (*e.g.*, showing to others one's environmental commitment) drive both IP and OF adoption, (2) moral concerns (*e.g.*, do not feel guilty about one's choices) increase the probability of organic farming adoption only, and (3) farmers who give high importance to economic concerns (*e.g.*, cutting production costs) are less likely to adopt OF.

Key-words: integrated protection, organic farming, social and moral concerns.

JEL classification: L15, L59, Q13.

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1. Introduction

Agricultural policies in several countries are experiencing a strong trend to become more ecologically-friendly. The mainstream model of production, based on intensive use of chemical inputs for crop protection such as pesticides, is increasingly challenged because of its environmental damages (*e.g.*, water pollution, harm to biodiversity, etc.) and the negative impacts on consumer and producer health (for example, the carcinogenic effect of some agrofood components). In response to the increasing demand for a more sustainable agriculture, several technical and institutional alternatives have been developed, such as conservation practices, integrated crop protection, organic farming, environmental management systems, retailers' specifications, and so on. These ecologically-friendly practices (or measures) can be positioned on a continuum from slightly conventional practices or greenwashing strategies to more stringent and highly sustainable ones. Without purporting to be exhaustive, they can be characterized as being (1) privately or publicly promoted, (2) tied to private or public benefits, (3) implemented at the farm level or along the supply chain, (4) voluntary or quasi-compulsory, and (5) signaled or not to consumers and/or shareholders.

The economic literature has largely investigated the drivers behind farmers' adoption of ecologically-friendly practices. It should be noticed that several studies are also devoted to the adoption of innovations, broadly defined (*e.g.*, Feder *et al.*, 1985; D'Souza *et al.*, 1993; Feder and Umali, 1993; Rogers, 1995 and references therein). Nevertheless, economists have mainly cited economic concerns as the main driver of adoption (Sheeder and Lynne, 2009). For instance, Cary and Wilkinson (1997) argue that the best way to increase the use of resource conservation practices, will be to ensure they are economically profitable. Chouinard *et al.* (2008) achieved an interesting review of the literature about conservation technology adoption and note that increasing profit or wealth is one of the most important reasons for which producers may engage in conservation practices. In the same vein, Musshoff and Hirschauer (2008, see also Padel, 2001) emphasize the prominence in general of financial reasons with regard to conversion to organic production.

However, based mainly upon works in behavioral economics (Simon, 1987; Kahneman, 2003; Camerer *et al.*, 2004), an increasing number of scholars recognize the role of non-economic concerns in the adoption decision to farmers. Several contributions (*e.g.*, Rigby *et al.*, 2001; Carlsson *et al.*, 2007) show that farmers are not only driven by monetary considerations but also change their behavior in reaction to moral and social ones. Moral concerns are those related to individuals' (intrinsic) ethics, such as personal satisfaction. Social concerns are those which shape the individual's behavior in relation to his/her reference group, for example, the other similar farmers in the same region. Among social concerns, let us consider the desire for status which has been recognized as a driver of human behavior. Several studies support the idea that farmers switched to intensive farming (Green Revolution) not only as a profit maximizing decision, but also because of the status benefits tied to the changes under consideration (*e.g.*, the French '*club des 100 quintaux'* in the 1980s which was including corn producers able to produce more than 100 quintal/ha). Lanneau (1967, see also Bessière, 2002) argues that the adoption of some innovations, such as the purchase of a tractor or huge equipments in the 1960s, was not only explained by economic requirements, but also the desire to progress in the social hierarchy.

The aim of this paper is to investigate empirically the role of moral and social concerns in farmers' decision to adopt ecologically-friendly practices, namely integrated crop protection (IP) and organic farming (OF). IP and OF are two voluntary practices implemented at the farm level and delivering a mix of private and public benefits. IP –also referred to in the economic literature as integrated plant protection (IPP) or integrated pest management (IPM) refers to crop protection techniques and practices which satisfy economic, ecological and toxicological requirements, while encouraging the use of natural pest control (Boller *et al.*, 1998). OF refers to the non-use of chemical inputs in the farming process in order to provide consumers with foodstuffs respecting natural life-cycle systems (European regulation EC 834/2007).[2] Beyond the use, or not, of chemical inputs, IP and OF differ at least on two other crucial issues. First, there is no official standard for IP, despite some attempts notably in the French fruit growing sector (Codron *et al.*, 2003 ; Bellon *et al.*, 2006). On the opposite, organic farming is standardized and farmers have also the possibility to signal their efforts using the French label and more recently the European label as defined by the regulation EC 834/2007. Second, farmers receive public financial support to adopt OF and not for IP adoption *per se*. As far as we know, only Swiss (big) farms receive direct subsides to adopt IP.

While a growing and relatively large literature is devoted to farmers' adoption of IP (*e.g.*, Harper *et al.*, 1990; Fernandez-Cornejo *et al.*, 1994; Fernandez-Cornejo and Ferraioli, 1999; Maumbe and Swinton, 2003; Mauceri *et al.*, 2007) and OF (*e.g.*, De Cock, 2005; Genius *et al.*, 2006; Parra-Lopez *et al.*, 2007; Cristoiu *et al.*, 2007; Musshoff and Hirschauer, 2008), this literature mainly focuses on the characteristics of farmers. For instance, by analyzing the determinants of IPM adoption among rice producers in the US (N=117), Harper *et al.* (1990) found that education has a significant effect on adoption. Fernandez-Cornejo *et al.* (1994) surveyed vegetable producers in the US (N=528) finding that labor availability, credit or debt ratio, farm size and farmer's age are significant drivers of IPM adoption. Similar findings have also been reported by Chaves and Riley (2001) who surveyed coffee producers in Colombia (N=392). According to Mauceri *et al.* (2007), access to information and

[2] Available at : http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:189:0001:0023:EN:PDF.

household size are the main drivers of IPM adoption by potato growers in Ecuador (N=109). In their analysis of the determinants of adoption of organic horticultural techniques in the UK (N=237), Burton *et al.* (1999) state that an individual's characteristics, mainly age and gender, and access to information are of paramount importance. They also argue that farmers concerned about environmental issues are more likely to adopt organic farming. Anderson *et al.* (2005) surveyed 175 farmers growing fresh-market produce in California and found similar results. This paper goes beyond the above-mentioned considerations and investigates the role of economic, social and moral concerns with regard to the adoption of integrated crop protection strategies and organic farming.

The remainder of the paper is organized as follows. Section 2 considers the theoretical arguments. It discusses the adoption of ecologically-friendly practices from a behavioral economics framework. Section 3 presents the data and methods. A multinomial logistic regression is specified to investigate the drivers of IP and OF adoption by 243 French fruit-growers and vegetable producers. Section 4 discusses the results. Section 5 concludes and highlights policy implications.

2. Behavioral economics and adoption of ecologically-friendly practices: literature and hypotheses

While neoclassical economic theory considers (extrinsic) economic motivations, behavioral economic literature (*e.g.*, Rabin, 1993; Frey, 1994; Camerer *et al.*, 2004; Frey and Stutzer, 2008) assumes that individuals have intrinsic and extrinsic motivations, including economic ones. Intrinsic motivations are reasons for action that come from within the individual, such as pleasure or personal satisfaction. An intrinsically motivated person performs an activity even when he or she receives no apparent reward except that derived from the activity itself. Extrinsic motivations are imposed on individuals from the outside. They can take several forms such as social recognition or monetary rewards to adopt a given behaviour and threats of punishment for failing to comply with a prescribed behavior. Behavioral economists identified several cognitive and behavioral anomalies that make individuals' behavior deviant from what is predicted in a neoclassical framework (Venkatachalam, 2008; Gowdy, 2008). Meier (2007) argues that individuals are not only self-interested actors but also act pro-socially, and, as such, their behavior maybe different from the standard model predictions. Manner and Gowdy (2010) argue that "emotions such as altruism, love, and envy are an essential part of the human experience." Fehr and Falk (2002) have also provided evidence that non-pecuniary concerns, such as the desire for social approval, may shape human behavior. They state that, if these concerns are ignored, economists may fail to understand the overall effect of economic instruments. Another part of literature has considered guilt aversion to test the relevance of human non-selfish behavior (*e.g.*, Battigalli and Dufwenberg, 2007 and references therein). According to Ellingsen *et al.* (2010), "people may feel guilty if their behavior falls short of others' expectations".

In the environmental realm, an increasing number of papers have recently started to explore the relevance of social and moral concerns when focusing on environmental sustainability and environmental compliance (*e.g.*, Venkatachalam, 2008; Frey and Stutzer, 2008). Frey and Stutzer (2008) argue that individuals might contribute to a public environmental good because of an "intrinsic motivation to act according to one's values". They also state that environmental morale and motivation are certainly more important than claimed in standard economics, and that environmental policies solely using price incentives would disregard their useful contribution to overcome environmental degradation. According to Torgler *et al.* (2008), past environmental policy may have inappropriately put emphasis on financial values for the environment. They argue that "environmental motivation, environmental morale or pro-environmental attitudes are highly relevant to an understanding of why people have a higher willingness to be involved in environmental protection." Venkatachalam (2008) shows how some behavioral anomalies could influence the overall environmental policies based on standard environmental economics and argues that "overlapping areas between behavioral economics and environmental economics provide an intellectual platform for a rich 'intradisciplinary' research and policy for sustainable development, which need to be pursued rigorously in the future". An increasing number of papers adds empirical content to the arguments above.[3] Brekke *et al.* (2003) used survey data on 1102 individuals in Norway to investigate, among other questions, their motivation for recycling. They found that moral concerns are important. For instance, 73% of their respondents stated they recycle because of a desire to regard themselves as responsible, while 41% do it because they want other people to think of them as responsible. Gilg and Barr (2006) list intrinsic concerns and satisfactions of doing environmental actions among the factors that could influence individual's behavior, notably related to water savings.

With regards to farmers' adoption of ecologically-friendly practices, economists have generally followed the same path and focused mainly on economic concerns. Nevertheless, this perspective is increasingly challenged by works in behavioral (ecological) economics. For instance, Sheeder and Lynne (2009) judges reasonable to hypothesize that egoistic-financial and social-moral concerns can influence conservation decisions made by farmers, based upon arguments advanced by behavioral economists and neuroscientists. Sheeder and Lynne (2009) report the results of several works showing that non-financial considerations, such as, farmer values and attitudes, can play a role in the conservation decision made by farmers. For example, Ervin and Ervin (1982) indicate that (moral) personal concerns may have a substantial impact on the number of adopted conservation practices by Missouri farmers. Maybery *et al.* (2005) show that conservation behavior is to some extent shaped by

[3] Several empirical studies not directly focused on environmental issues provide evidence that moral and social incentives matter (*e.g.*, Easterlin, 1995; Mui, 1995; Solnick *et al.* 2007). Despite their interest, these results are out of the scope of this paper.

farmers' values and attitudes. Sheeder and Lynne (2009) also argue that, "even when facing difficulties, many agricultural producers have maintained an attitude and ethic that treats farming and ranching as "*a way of life*," and not a venture to maximize profits". Torgler *et al.*'s (2009) manuscript about littering practices in 30 European countries added empirical content to the argument that environmental behavior of individuals is influenced by the perception of others' behavior.

In sum, as shown by Chouinard *et al.* (2008), while a huge part of the economic literature has focused exclusively on financial concerns, assuming that only profits and/or costs matter, another part tried to add social and moral concerns in an ad hoc way. Nevertheless, recent literature has started to explore adoption of ecologically-friendly practices by integrating more substantively the both approaches. In the same line, this paper explores two hypotheses:

- ✓ H1: Moral and social concerns matter in farmers' decisions about ecologically-friendly practices.
- ✓ H2: Moral and social concerns matter differently according to the protection methods used by farmers, that is, conventional farming, integrated crop protection or organic farming. Without speculating on which kind of farmer is characterized by a given concern, it seems intuitive that when economic concerns are not very important, moral and social ones would be. In other words, offsetting a relative economic advantage suggests that moral and social ones are more intense, *ceteris paribus*.

3. Data and methods

Between December 2008 and March 2009, we conducted a mail survey of 1286 fruit-growers and vegetable producers located in the French areas of *Alpes de Haute Provence*, *Hautes-Alpes* and *Vaucluse* (the whole population in these areas). These locations belong to the French *Region PACA* (*Provence-Alpes-Côte d'Azur*) which is the leading area in terms of organic production and the main hosting of biodiversity in France. These locations are also characterized by a weak presence of agriculture, compared to other areas in the country, which makes environmental issues, notably the production of agricultural amenities, particularly important. Moreover, fruit-growing and vegetable production in this area are substantial users of pesticides. For instance, while only 1% of the global French agricultural area is devoted to fruit growing, this type of production uses 21% of the whole volume of pesticides used in France.

All respondents were asked to indicate the crop protection method they use the most, *i.e.*, conventional, integrated protection or organic farming, and then to answer a question formulated as follows: *'How important is this factor to you in the choice of your crop protection method?'* Ten factors have been proposed encompassing economic, moral and social concerns. To measure the importance of these concerns, one needs to define some proxies. Choosing proxies for economic concerns is relatively simple, since the literature is very large concerning this issue. In line with several preceding papers, we use the following proxies: cutting production costs, meeting customers' requirements, diminishing the risk of output loss, getting a competitive advantage and benefiting from public financial support. Nevertheless, when looking to moral and social concerns things are a bit more complicated. The economic literature devoted to this issue is very heterogeneous. Taking into account moral and social concerns differs largely from one study to another. For instance, while some authors (*e.g.*, Frank, 1985; Easterlin, 1995) focus mainly on status seeking and relative standings when looking to moral and social concerns, others (*e.g.*, Mui, 1995; Fehr *et al.*, 2008) have focused on envy. Several authors have also focused on behavioral anomalies or biases originally investigated by sociologists and psychologists (attribution bias, optimism bias, loss aversion and so on). With regards to agriculture, previous studies have mainly considered moral and social concerns in terms of the desire for distinction, social values and conformism behaviors. In line with these studies, we use in this paper doing the right thing and do not feel guilty about own choices to measure moral concerns. Satisfying other landscape users' demands, being perceived the top one by the other farmers, and showing to others one's environmental commitment are used to measure social concerns.

Moreover, the methods used are also heterogeneous, since the economic literature related to this issue is rather recent and there is not yet a 'common' method to measure such aspects. Some scholars use survey data based upon hypothetical questions, whereas others use field experiments. In this paper, a 5-point Likert scale has been used to measure the importance of economic, moral and social concerns, where 5 indicates that the concern is very important and 1 the lowest importance. One may wonder whether the use of Likert scales might lead to problems in the sense that some farmers find everything important while others tend to use the lower part of the scales. Nevertheless, only 4 farmers in the sample gave the same answer for all the proxies considered.

We received 243 fully filled responses (19%) covering 134 conventional farmers, 71 farmers using IP and 38 organic farmers. Such a response rate may appear as not very high. Nevertheless, it is generally difficult in France to have much more responses. For instance, Grolleau *et al.* (2007) investigated the determinants of environmental management systems adoption by French agrofood firms. Out of the 1,000 firms surveyed, 215 responded. This difficulty of surveying French firms is also reported in Henriques *et al.* (2004) who investigated environmental practices in several OECD countries. They say response rates range from 9.3% in France to 34.7% in Norway for an average response rate of 24.7%. Finally, Harzing (2000) investigated the differences between response rates in a cross-national industrial mail survey in 22 countries. She found that while for some countries such as Norway the response rate was about 40%, for other countries, such as France it was only about 13%. Moreover, such a response rate might induce selection bias. While we do not account for such possible bias, it should be noticed that the characteristics of the farms in our sample are not largely deviant from those of the whole population. For instance, up to December 2009, the percentage of organic fruit-growers in the *Provence* region was about 7%.[4] It should be noticed that the questionnaire was elaborated after direct interviews of about two hours each with experts in the agricultural field and 7 farmers which allowed us to better identify the concerns they take into account when choosing their crop protection method. In order to improve its readability, the questionnaire was pre-tested on 15 farmers from another area.

To investigate empirically the drivers of farmers' adoption of IP/OF, we use a multinomial logit (MNL) regression. MNL models assume that the error terms are independently and identically distributed (Greene, 2003). They are used to model relationships between a polytomous response variable and a set of regressor variables. These polytomous response models can be classified into two distinct types, depending on whether the response variable has an ordered or unordered structure. In this case, each farmer chooses one of the mutually exclusive alternatives characterized by the categorical variable. This variable includes three distinct unordered alternatives: conventional methods, integrated protection and organic farming. Hence, we specify an unordered MNL model (discrete choice method) as follows (Greene, 2003):

$$\mathrm{Prob}(Y_i = j) = \frac{e^{X_i\beta_j}}{\sum_{k=1}^{3} e^{X_i\beta_k}} \text{ with } j = 1,2,3.$$

where Y_i, the dependent variable, represents the protection method used by the farmer and takes the values of 1, 2 or 3 if the farmer uses conventional methods, integrated protection or organic farming, respectively. Here conventional farming is used as the reference category. X_i represents a vector of explanatory variables and encompasses the above-mentioned economic, moral and social concerns (cutting production costs, meeting customers' requirements, diminishing the risk of output loss, getting a competitive advantage, benefiting from public financial support, doing the right thing, do not feel guilty about own choices, satisfying other landscape users' demands, being perceived the top one by the other farmers, showing to others one's environmental commitment), and, a set of control variables (age, gender, education, and main activity). Indeed, it is widely acknowledged that adoption of an innovation is related to socio-demographic characteristics (Parra-Lopez *et al.*, 2007). As stressed by several previous studies (Fernandez-Cornejo *et al.*, 1994; Torgler and García-Valiña, 2007), younger people, women and more educated farmers are more likely to exhibit eco-friendly behaviors. Given the larger variety of vegetable productions compared to fruit-growing, it is also expected that adoption differs according to the main activity of the farmer. β_i represent slope coefficients to be

[4] http://www.agencebio.org/. Unfortunately, we do not have data about the proportion of IP among the whole population.

estimated. The results of the MNL model are interpreted in terms of the odds ratios, that is, the ratios of the probability of choosing one outcome category over the probability of choosing the reference category. These ratios are defined as:

$$\ln\left[\frac{P_{ij}}{P_{ik}}\right] = X_i\left(\beta_j - \beta_k\right) = X_i\beta_j \;\; if \;\; k = 1.$$

Therefore, a positive parameter means that the relative probability of choosing IP/OF increases relative to the probability of choosing conventional farming. To better interpret the sensitivity of the probability of IP/OF adoption with respect to explanatory variables, we compute marginal effects. The higher the marginal effect is, the higher the impact of the explanatory variable on dependent one is. As it is common for discrete variables, the marginal effect is calculated as the difference between the probabilities estimated at the sample means when the dummy variable takes the values of 1 and 0, respectively. We also perform a Wald test for joint significance of moral and social concerns to investigate their relevance as a group, that is, instead of estimating several coefficients for each concern, we estimate a coefficient for more than one concern, here moral and social ones.

4. Results and discussion

The variables used in estimation and sample statistics are indicated in Table 1. In order to focus on the case where the studied concerns are important, explanatory variables are dichotomous. For each economic, moral and social concern, we considered it important if the farmer checked 4 or 5 on the Likert scale. No problem of multicollinearity has been detected (see Appendix 1).

[Insert Table 1 around here]

Several results can be drawn from the simple statistics in Table 1 which confirm our hypotheses. First, moral and social concerns matter among the surveyed fruit-growers and vegetable producers along with economic ones. More than 76% of the respondents indicated that doing the right thing is important when choosing the crop protection method, less than meeting customers' requirements (80%), but more than reducing risks (73%) and cutting production costs (57%). Do not feel guilty about own choices, showing to others one's environmental commitment and satisfying landscape users' demands are also important, since 55%, 48% and 39% of respondents, respectively, stated they are important concerns. An unexpected result relates to being perceived the top one by other farmers, with only 16% of respondents considering it important.

Second, moral, social and economic concerns matter differently according to the protection method used by the farmer. The Wilcoxon test shows that except showing to others one's environmental commitment (*SHOW*), there is no significant difference between conventional farmers and those using integrated crop protection, while the responses of organic farmers are significantly different from both. For instance, organic farmers give significantly more attention to doing the right thing and guilty feelings (moral concerns), but give significantly less importance to reducing production costs and risks (economic concerns) compared to the rest of the population. This result can be partly explained by the fact that organic farming is a standardized model and thus there are less problems of comprehension in relation to its principles among farmers. However, IP still lacks a rigorous definition and farmers may confuse it with other methods. So, some farmers may have mentioned they use IP while their practices correspond more to conventional ones, as reported by several studies (*e.g.*, Bellon *et al.*, 2006; Bonny, 1997). Unfortunately, the data do not allow us to deal with such a problem. However, as stated by Hayek (1952), "as far as human actions are concerned, things are what people think they are." Nevertheless, when things are not what farmers perceive them, this may constitute an obstacle to the adoption of ecologically-friendly practices, because farmers think that what is required by society is what they are doing yet.

Nevertheless, it can be argued that farmers may have indicated socially desirable answers, since becoming an organic farmer because of moral reasons may be higher valued than becoming an organic farmer because of economic ones.[5] A possible way to solve this issue, at least partially, is to use farmers' income as a control variable. Unfortunately, this variable was not well reported and we have decided to drop it in order to not decrease drastically the number of observations. In addition, the few papers that focus on the economic performance of organic farming do not give clear-cut conclusions. While some authors (*e.g.*, Nieberg and Offermann, 2003) argue that organic production allows relatively high price premiums, others argue that OF is not more profitable than conventional farming (Klonsky and Greene, 2005). Thanks to a review of the literature on profitability of organic farming, Greer *et al.* (2008) report that the profitability of organic and conventional farms in the EU and the US has generally been found to be similar. Interestingly, Acs, Berentsen and Huirne (2007, see Acs *et al.*, 2007) report higher income for organic farming. However, after taking into account some factors likely to influence conversion, namely, extra depreciation costs, hired labor availability, organic market price uncertainty and minimum labor income requirement, OF may become less profitable than staying conventional. Acs *et al.* (2009) argue also that if farmers are risk-averse, "it is only optimal to fully convert if policy incentives are applied such as taxes on pesticides or subsidies on conversion, or if the market for the organic products becomes more stable". In sum, results are mixed and this point deserves further academic attention.

Third, the proportion of women is significantly higher in OF, compared to conventional agriculture. Moreover, relatively more fruit growers use IP, probably because there are less technical possibilities for integrated crop protection in the vegetable production.

[5] This point has been appropriately stressed by one of the reviewers.

To analyze the factors of IP/OF adoption with more control, we present the results of the multinomial logistic regression (Table 2) together with goodness-of-fit measures (Maximum Likelihood estimation).[6] The R2 of 0.17 indicates that unobserved individual heterogeneity is still relatively important in the data.[7] For ease of exposition, the marginal effects are only discussed when it is the most appropriate.

[Insert Table 2 around here]

These findings partially confirm our hypothesis 1 that moral and social concerns matter. Farmers thinking that showing to others one's environmental commitment (*SHOW*) is important are more likely to adopt IP and OF (compared to the reference category), since for one unit change in the variable *SHOW*, the log of the ratio of the probability of choosing IP (respectively, OF) over the probability of choosing the reference category, that is, conventional protection, will be increased by 0.663 (respectively, 1.182). Noteworthy, when considering OF adoption, the variable *SHOW* is significant at the 5% level with a marginal effect of 0.08. However, when considering IP adoption, it is only significant at the 10% level with a marginal effect of 0.13, which may indicate, to some extent, that this factor is relatively more important when choosing OF. Do not feeling guilty about one's choices (*GUILTY*) only influences adoption of organic farming. This result might be explained by the fact that, contrarily to OF, IP combines natural and chemical inputs. Nonetheless, it should be noticed that *GUILTY* is only significant at the 10% level (the weakest statistical power compared to the other variables) and has one of the lowest marginal effects (0.085). Moreover, while the variables *USERS* (satisfying landscape users' demands) and *PERCEPTION* (being perceived the top one by other farmers) are non-significant, the Wald-test for joint significance of moral and social concerns indicates their relevance as a group in understanding farmer's attitudes.

[6] For readers not familiar with statistical measures, let us explain that the Log likelihood (LL) is mentioned to indicate that the model fits. Maximum likelihood estimation is an iterative procedure. When the difference between successive iterations is very small, the model is said to have converged and the results are displayed. The LL is also used to compute the Likelihood Ratio Chi-Square, LR Chi2, which indicates that for both regressions at least one of the coefficients is not equal to zero (for more details see: http://www.ats.ucla.edu/stat/stata/output/stata_mlogit_output.htm).

[7] One may question the power of expression of the model used given the low level of Pseudo R2. Nevertheless, it is generally difficult with MNL models to have a high Pseudo R2, especially when the number of observations is relatively low, since the regression divides the sample into several categories. Regardless of its level, the R2 is mainly used here to compare different models. As stressed by Hosmer and Lemeshow (2000) "low R2 values in logistic regression are the norm and this presents a problem when reporting their values to an audience accustomed to seeing linear regression values (...) However, they [R2 values] may be helpful in the model building state as a statistic to evaluate competing models".

Table 2 also shows that economic concerns negatively influence OF adoption, which supports to some extent hypothesis 2. Farmers who think that cutting production costs (*COST*) and reducing the risk of output loss (*RISKS*) are important are less likely to adopt OF. For one unit change in the variable *COST* (respectively, *RISKS*), the log of the ratio of the probability of choosing OF over the probability of choosing the reference category, will be decreased by 1.54 (respectively, 1.664). These variables have also the highest marginal effects (0.18 and 0.25, respectively). Interestingly, when considering OF adoption, these variables are the only ones which are significant at the 1% level, which may suggest that not only economic considerations play a strong role in farmers' decisions, but also that the latter may 'still' perceive organic farming as relatively costly and risky. However, *COST* and *RISKS* are non-significant with regards to IP adoption. This result can be explained by the fact that conversion costs and risks are generally higher for OF than for IP. Moreover, farmers who wish to get a competitive advantage (*COMPETITION*) are less likely to adopt IP. The marginal effect of 0.205 and the significance of this variable at the 1% level indicate that this variable is among the most important concerns when choosing conventional methods over IP. The negative sign may be explained by the fact that competition may depend on dimensions other than environmental considerations, for example, the level of production or equipment. Interestingly, while organic farmers receive subsidies for their conversion and production, the variable *SUPPORT* (getting support from public authorities) is only significant with regards to IP adoption. Two facts can explain this result. First, since farmers can receive public funds for several environmental investments, such as the adoption of good agricultural practices, IP can constitute a leverage to this financial support. This point was raised by a fruit-grower interviewed before the survey. The grower stated that he was willing to introduce an integrated crop protection technique, namely mating disruption, in 2009, in order to benefit from funds from the 'plant plan for the environment' (*plan végétal pour l'environnement*).[8] Second, subsidies for organic farming remain relatively low and the profitability relates mainly to the price premium paid by consumers to purchase organic products. Moreover, the variable *CUSTOMERS* (meeting customers' requirements) is not significant either for IP or OF adoption. As indicated in Table 1, farmers rank this aspect as highly important, whatever the crop protection strategy.

As for control variables, results show that *AGE* is not significant, *GENDER* is significant only for farmers using integrated protection, education (*EDUCATION*) has only a significant impact on organic farming adoption, and fruit-growers (*ACTIVITY*) are more likely to adopt IP than vegetable producers.

Furthermore, several versions of the model are estimated, to investigate the robustness of results to variable omission (Table 3). In Model 1 we have focused only on the 'traditional' concerns. In Model

[8] The plant plan for the environment is a part of the French rural development plan (2007-2013) aiming at to helping farmers in their environmental investments.

2 the variable *GUILTY*, measuring moral concerns, is excluded, whereas in Model 3, social concerns are excluded.

[Insert Table 3 around here]

In all estimations, the Pseudo R2 (between 0.13 and 0.15) is lower than 0.17 which indicates that adding the moral and social concerns into specification is more appropriate. In addition, the main results presented above (Table 2) are robust to variable omissions. For instance, Model 2 indicates that even when omitting the variable *GUILTY*, farmers thinking that showing to others one's environmental commitment is important are more likely to adopt IP and OF. The coefficients associated to the variable *SHOW* (0.584 and 1.142) are also very close to those reported in Table 2. The variable *GUILTY* remains significant with regards to OF adoption, even when social concerns are excluded (Model 3). Moreover, similarly to Table 2, all estimations in Table 3 show that the variables *USERS* and *PERCEPTION* are non-significant. It is also interesting to note that the variables *COST* and *RISKS* are negatively significant at the 1% level in all estimations. As for control variables, the results do not largely differ from those reported in Table 2, except for the variable *GENDER*, which is non-significant in all estimations, while in Table 2 it was a significant driver at the 10% level of IP adoption.

Finally, we re-run the analysis by using composite variables (*i.e.*, moral, economic and social) instead of using the individual ones (*e.g.*, do not feel guilty, showing to others, cutting costs, etc.). These composite variables are computed as the sum of the individual binary ones. Thus, *MORAL* (respectively *SOCIAL*) can take values between 0 when *RIGHT* and *GUILTY* (respectively *USERS*, *PERCEPTION* and *SHOW*) are equal to 0 and 2 (respectively 3) when they are equal to 1. Similarly, the variable *ECONOMIC* can take values between 0 when all individual economic concerns (that is, *COST*, *CUSTOMERS*, *RISKS*, *COMPETITION* and *SUPPORT*) are equal to 0, and 5 when they are are equal to 1.

[Insert Table 4 around here]

The results in Table 4 are similar to those reported in Tables 1 and 2, confirming our hypothesis 1 that moral and social concerns matter. They show that moral concerns positively influence organic farming adoption, since the variable *MORAL* is significant at the 1% level. This variable has also the highest marginal effect (0.15). Table 4 also shows that social considerations drive both IP and OF adoption. Nevertheless, while *SOCIAL* is significant at the 5% level when considering OF, it is only significant at the 10% level when considering IP. The marginal effect is also only significant for the former. Last but not least, results in Table 4 suggest that farmers who give high importance to economic considerations are less likely to adopt OF, which is consistent with the results of the basic model reported in Table 2.

5. Concluding remarks

This paper provides a better understanding of farmers' decision to adopt ecologically-friendly practices. We have shown that beyond the role played by economic concerns, moral and social ones matter amongst French fruit-growers and vegetable producers and are significant drivers of integrated crop protection and organic farming adoption. These results suggest that only focusing on economic incentives may be useful but partial. Ignoring these aspects can lead to flawed considerations. For instance, farmers are likely to adopt ecologically-friendly practices to show their commitment to others. Regulators may take into account such aspects by making farmers' efforts more visible, for example, through awards to those who protect the environment the most.[9] Recent behavioral economics work (*e.g.*, Frey and Neckermann, 2009) stresses that awards can constitute a more effective policy tool than monetary compensations. Even innovations that are both profitable and ecologically-friendly may suffer from a low diffusion rate because their capacity to confer moral and social benefits has been ignored. More precisely, increasing the non-economic benefits of socially desirable innovations, such as IP and OF, may be a complementary and more efficient way of promoting them among potential adopters. Moreover, our results show that guilty feelings are important for farmers. Consequently, creating a state of cognitive dissonance among farmers, *i.e.*, incoherence between their intrinsic values and their actions can push them to adopt ecologically-friendly farming to be relieved. Furthermore, while several scholars argue that less chemical inputs are likely to reduce the costs incurred by farmers, and although public authorities often use these input gains to encourage farmers to reduce the use of chemicals, we have shown that farmers who wish to reduce production costs are less likely to adopt ecologically-friendly practices, maybe because they do not perceive this predicted cost reduction. As such, this finding suggests that those public policies may be less effective than expected.

Furthermore, economic, moral and social concerns matter differently according to the protection method used by farmers. This result suggests that public authorities should take into account not only the multiplicity of motivations but also the way these motivations can be combined. This issue recalls the debate concerning the crowding in/crowding out situation (Fehr and Falk, 2002; Frey and Stutzer, 2008). Economic motivations, such as paying people, may crowd out (crowd in) moral motivations, such as doing the right thing, because they undermine (reinforce) self-determination and self-esteem. In the crowding out situation, the individual feels pressured by an external force, and therefore feels over justified in maintaining his moral motivation rather than complying with the will of the source of the economic reward. Moreover, economic motivations cause an individual to feel that his/her internal motivation is rejected, not valued, leading him/her to reduce his/her self-esteem and thus to reduce effort (Frey and Oberholzer-Gee, 1997 ; Gneezy and Rustichini, 2001). Although difficult to capture,

[9] One may argue that as the number of farmers who wish to show their environmental commitment increases, this concern may become less important for them. This issue deserves more attention in future research.

taking into account these issues is a crucial step toward more efficient and effective policies, and an important topic for future research. This is particularly interesting when considering environmental policy which is characterized by several kinds of external interventions, notably through command-and-control and market-based instruments (Frey and Stutzer, 2008).

Nevertheless, our study has some limitations that should be taken into account in future research. First, the number of observations remains relatively low to gather rigorous information regarding moral and social concerns. Increasing the sample of surveyed farmers may allow having more clear-cut conclusions. Moreover, due to the relatively low rate of responses, we were not able to test for differences among the three different regions. Second, we have ignored in our estimation a set of exogenous concerns that are likely to generate adoption, such as regulation, the distance between a farmer's house and farm, etc. For instance, it seems intuitive that an individual who lives on his/her farm maybe more sensitive to chemical inputs reduction, notably in presence of children.[10] Asking questions in regards to farmers' perceptions on how other farmers behave would also have been interesting. Taking into account these considerations is a challenging topic for future research. It would be also interesting to consider the date of adoption and the conversion process followed by farmers, that is, whether they moved directly from conventional to organic farming or took a step by step approach starting by adoption of IP. Third, our study focuses on fruit-growers and vegetable producers in three French areas. Covering more activities and areas is likely to generate fruitful results. A cross-country comparison also would constitute an interesting extension of our work.

[10] Noteworthy, the farm was the farmer's house for several decades in France. Nevertheless, this situation is increasingly changing mainly among young farmers, notably due to some institutional constraints, which prevent individuals from building their houses on the farm, in order to preserve land agricultural use.

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Table 1: Variables description and sample statistics

Variable	Definition	All farmers (N=243)		Conventional (N=134)		Integrated (N=71)		Organic (N=38)		Wilcoxon test		
		Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	C/IP	C/OF	IP/OF
PROTECTION *(Dependent variable)*	Categorical variable (=1, 2 or 3 if the farmer chooses a conventional protection method, IP or OF, respectively)	1.604	0.744	1	0	2	0	3	0	-	-	-
Moral concerns												
RIGHT	Dummy variable (=1 if the farmer thinks that doing the right thing is important)	0.761	0.427	0.708	0.455	0.732	0.445	1	0	ns	***	***
GUILTY	Dummy variable (=1 if the farmer thinks that do not feel guilty about his own choices is important)	0.559	0.497	0.537	0.500	0.521	0.503	0.710	0.459	ns	**	*
Social concerns												
USERS	Dummy variable (=1 if the farmer thinks that satisfying landscape users is important)	0.390	0.488	0.350	0.478	0.394	0.492	0.526	0.506	ns	*	ns
PERCEPTION	Dummy variable (=1 if the farmer thinks that being perceived the top one by the other farmers is important)	0.168	0.375	0.171	0.378	0.197	0.400	0.105	0.311	ns	ns	ns
SHOW	Dummy variable (=1 if the farmer thinks that showing one's environmental commitment to others is important)	0.485	0.500	0.410	0.493	0.549	0.501	0.631	0.488	*	**	ns
Economic concerns												
COST	Dummy variable (=1 if the farmer thinks that cutting production costs is important)	0.576	0.495	0.619	0.487	0.647	0.481	0.289	0.459	ns	***	***
CUSTOMERS	Dummy variable (=1 if the farmer thinks that meeting customers' requirements is important)	0.806	0.395	0.791	0.408	0.845	0.364	0.789	0.413	ns	ns	ns
RISKS	Dummy variable (=1 if the farmer thinks that reducing risks is important)	0.732	0.443	0.798	0.402	0.802	0.400	0.368	0.488	ns	***	***
COMPETITION	Dummy variable (=1 if the farmer thinks that getting a competitive advantage is important)	0.246	0.432	0.261	0.440	0.169	0.377	0.342	0.480	ns	ns	**
SUPPORT	Dummy variable (=1 if the farmer thinks that public support is important)	0.292	0.455	0.268	0.444	0.366	0.485	0.236	0.430	ns	ns	ns
Farmers' characteristics												
AGE	Dummy variable (=1 if farmer's age is under 40)	0.205	0.405	0.231	0.423	0.183	0.389	0.157	0.369	ns	ns	ns
GENDER	Dummy variable (=1 if the farmer is female)	0.172	0.378	0.126	0.334	0.197	0.400	0.289	0.459	ns	***	ns
EDUCATION	Dummy variable (=1 if the farmer's level of education is high school)	0.456	0.499	0.417	0.495	0.492	0.503	0.526	0.506	ns	ns	ns
ACTIVITY	Dummy variable (=1 if the main activity of the farmer is fruit-growing)	0.580	0.494	0.544	0.499	0.732	0.445	0.421	0.500	***	ns	***

The Wilcoxon test compares conventional farmers (C), farmers using integrated protection (IP) and organic farmers (OF). (*), (**) and (***) stand for parameter significance at the 10, 5 and 1 percent level, respectively.

Table 2: Multinomial logistic estimates of IP/OF adoption

Variables	Integrated protection			Organic farming		
	Estimate	z-value	Marginal effect	Estimate	z-value	Marginal effect
INTERCEPT	-1.846***	-3.19	-	-1.127*	-1.77	-
Moral concerns						
GUILTY	-0.509	-1.45	-0.129	0.918*	1.87	0.085**
Social concerns						
USERS	0.347	0.95	0.066	0.224	0.45	0.009
PERCEPTION	0.268	0.59	0.078	-0.956	-1.37	-0.065
SHOW	0.663*	1.86	0.104	1.182**	2.44	0.080**
Economic concerns						
COST	-0.188	-0.53	0.008	-1.540**	-3.12	-0.137***
CUSTOMERS	0.097	0.22	0.028	-0.317	-0.56	-0.031
RISKS	0.121	0.29	0.084	-1.664***	-3.63	-0.196***
COMPETITION	-1.091**	-2.38	-0.212***	0.671	1.28	0.095
SUPPORT	0.649*	1.75	0.146*	-0.216	-0.40	-0.033
Farmers' characteristics						
AGE	-0.300	-0.71	-0.043	-0.812	-1.26	-0.049
GENDER	0.749*	1.65	0.148	0.553	1.04	0.023
EDUCATION	0.562	1.60	0.091	0.908*	1.83	0.060
ACTIVITY	0.999**	2.77	0.194***	0.167	0.36	-0.011
Pseudo R2	0.1734					
Log likelihood	-196.41559					
LR Chi2(26)	82.42					
Wald test: joint for moral and social concerns (GUILTY=USERS=PERCEPTION=SHOW=0)	18.04**					
Number of observations	243					

(*), (**) and (***) stand for significance at the 10, 5 and 1 percent level, respectively. The z value is computed as the estimated coefficient divided by its robust-estimated standard error. The variable *RIGHT* (doing the right thing) has not been used in estimation since all organic farmers stated it was important.

Table 3: Check of the robustness of the overall results to the omission of some variables

	Model 1 (omitting moral and social concerns)						**Model 2 (omitting moral concerns)**						**Model 3 (omitting social concerns)**					
	Integrated protection			**Organic farming**			**Integrated protection**			**Organic farming**			**Integrated protection**			**Organic farming**		
Variables	Estimate	z-value	Marginal effect	Estimate	z-value	Marginal effect	Estimate	z-value	Marginal effect	Estimate	z-value	Marginal effect	Estimate	z-value	Marginal effect	Estimate	z-value	Marginal effect
INTERCEPT	-1.650***	-2.99	-	-0.302	-0.55	-	-1.928***	-3.33	-	-0.875	-1.44	-	-1.565***	-2.83	-	-0.644	-1.09	-
Moral concerns																		
GUILTY	-	-	-	-	-	-	-	-	-	-	-	-	-0.247	-0.76	-0.079	0.994**	2.17	0.094**
Social concerns																		
USERS	-	-	-	-	-	-	0.224	0.63	0.032	0.493	1.05	0.037	-	-	-	-	-	-
PERCEPTION	-	-	-	-	-	-	0.188	0.42	0.059	-0.793	-1.14	-0.058	-	-	-	-	-	-
SHOW	-	-	-	-	-	-	0.584*	1.67	0.088	1.142**	2.43	0.082**	-	-	-	-	-	-
Economic concerns																		
COST	-0.176	-0.51	0.007	-1.265***	-2.76	-0.124**	-0.270	-0.77	-0.008	-1.482***	-3.06	-0.132***	-0.134	-0.39	0.016	-1.340***	-2.88	-0.130***
CUSTOMERS	0.253	0.62	0.049	0.030	0.06	-0.004	0.140	0.32	0.035	-0.247	-0.44	-0.026	0.247	0.60	0.053	-0.128	-0.24	-0.019
RISKS	0.004	0.01	0.076	-1.758***	-4.04	-0.230***	0.102	0.25	0.083	-1.645***	-3.66	-0.199***	-0.015	-0.04	0.068	-1.731***	-3.89	-0.217***
COMPETITION	-0.697*	-1.71	-0.155**	0.749	1.55	0.108	-0.988**	-2.21	-0.201***	0.717	1.37	0.103	-0.722*	-1.76	-0.155**	0.643	1.31	0.091
SUPPORT	0.606*	1.74	0.130*	0.027	0.05	-0.017	0.564	1.55	0.125	-0.087	-0.16	-0.023	0.649*	1.84	0.142*	-0.033	-0.06	-0.022
Farmers' characteristics																		
AGE	-0.343	-0.83	-0.045	-0.957	-1.58	-0.066	-0.305	-0.72	-0.041	-0.917	-1.47	-0.057	-0.331	-0.80	-0.045	-0.881	-1.42	-0.059
GENDER	0.597	1.38	0.109	0.561	1.12	0.034	0.682	1.53	0.127	0.680	1.32	0.039	0.615	1.41	0.118	0.471	0.91	0.023
EDUCATION	0.550	1.61	0.086	0.874*	1.87	0.066	0.578*	1.66	0.093	0.933*	1.94	0.064	0.543	1.58	0.085	0.875*	1.82	0.064
ACTIVITY	0.933***	2.68	0.183***	0.097	0.22	-0.018	0.930***	2.62	0.180***	0.246	0.53	-0.003	0.978***	2.77	0.195***	-0.027	-0.06	-0.030
Pseudo R2	0.1315						0.1576						0.1458					
Log likelihood	-206.36559						-200.17828						-202.98183					
LR Chi2	62.52						74.89						69.29					
Number of observations	243						243						243					

(*), (**) and (***) stand for significance at the 10, 5 and 1 percent level, respectively. The z value is computed as the estimated coefficient divided by its robust-estimated standard error. The variable *RIGHT* (doing the right thing) has not been used in estimation since all organic farmers stated it was an important factor.

Table 4: Multinomial logistic estimates of IP/OF adoption (using composite factors)

Variables	Integrated protection			Organic farming		
	Estimate	**z-value**	**Marginal effect**	**Estimate**	**z-value**	**Marginal effect**
INTERCEPT	-1.472***	-2.95	-	-2.016***	-2.86	-
MORAL	-0.183	-0.85	-0.074	1.180***	3.21	0.112***
SOCIAL	0.301*	1.71	0.048	0.504**	2.11	0.036*
ECONOMIC	-0.034	-0.24	0.015	-0.757***	-3.66	-0.067***
AGE	-0.503	-1.23	-0.089	-0.392	-0.71	-0.020
GENDER	0.618	1.46	0.109	0.711	1.43	0.048
EDUCATION	0.535	1.59	0.096	0.538	1.24	0.032
ACTIVITY	0.955***	2.77	0.199***	-0.227	-0.53	-0.049
Pseudo R2	0.1180					
Log likelihood	-209.58324					
LR Chi2(14)	56.08					
Wald test: joint for MORAL and SOCIAL	20.41***					
Number of observations	243					

(*), (**) and (***) stand for significance at the 10, 5 and 1 percent level, respectively. The z value is computed as the estimated coefficient divided by its robust-estimated standard error.

Appendix 1: Pearson correlation coefficients

	PROTECTION	AGE	GENDER	EDUCATION	ACTIVITY	COST	CUSTOMERS	RISKS	COMPETITION	SUPPORT	GUILTY	USERS	PERCEPTION	SHOW
PROTECTION	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-
AGE	-0.07	1.00	-	-	-	-	-	-	-	-	-	-	-	-
GENDER	0.15	0.03	1.00	-	-	-	-	-	-	-	-	-	-	-
EDUCATION	0.08	0.33	0.19	1.00	-	-	-	-	-	-	-	-	-	-
ACTIVITY	-0.01	-0.04	-0.11	-0.14	1.00	-	-	-	-	-	-	-	-	-
COST	-0.18	0.00	-0.04	-0.06	0.31	1.00	-	-	-	-	-	-	-	-
CUSTOMERS	0.02	0.06	0.05	-0.03	0.13	0.10	1.00	-	-	-	-	-	-	-
RISKS	-0.28	0.07	-0.21	0.06	0.14	0.19	0.01	1.00	-	-	-	-	-	-
COMPETITION	0.02	0.20	0.04	-0.02	0.04	0.08	0.11	-0.02	1.00	-	-	-	-	-
SUPPORT	0.01	-0.01	-0.03	-0.17	0.12	0.22	0.10	0.02	0.19	1.00	-	-	-	-
GUILTY	0.09	-0.02	0.05	-0.08	0.15	0.19	0.09	-0.03	0.10	0.15	1.00	-	-	-
USERS	0.11	0.00	-0.03	-0.00	-0.01	0.03	0.28	-0.12	0.16	-0.05	0.25	1.00	-	-
PERCEPTION	-0.04	0.06	-0.06	-0.08	0.16	0.14	0.08	0.04	0.32	0.09	0.17	0.11	1.00	-
SHOW	0.17	-0.04	-0.00	-0.09	0.07	0.13	0.10	-0.08	0.24	0.22	0.24	0.26	0.28	1.00