How does networks membership and neighborhood influence French farmers' decision to adopt agri-environmental contracts?

Annyssa ANDRIAMBELONA[1]

October 2015

****

Abstract:

Due to the voluntary nature of the Local Agri-Environmental Schemes (LAES) implemented in France in 2007-2013 to limit the problem of water quality contamination by agricultural runoff, high farmer adoption rate is important for achieving the program effectiveness. This paper aims at assessing the determinants of farmers' participation in such agri-environmental programs, with an emphasis on the role played by farmers' social and spatial networks. We first develop a microeconomic model which relates social network effects to new agri-environmental technology adoption patterns. We then test the empirical implications of this model by using individual data on farmers' information and advisory LAES-related networks collected in three French Local AES territories, where a nitrate and pesticides pollution control program has been implemented. For that, a probit model, corrected from spatial autocorrelation, and a Heckman selection model are used. Our results show that the existence of strong links with the local project coordinator and the involvement of farmers' cooperatives in the LAES program coordination affect positively the adoption of agri-environnemental contracts whereas farmers unions tend to discourage participation. Spatial neighborhood, as a more informal discussion circle, also acts as a significant channel of information diffusion, affecting farmers' decision to uptake measures. For the agri-environnemental project coordinator, developing collaborative and trustworthy relationships with local organizations, namely those who benefit from farmers' confidence, in the design and the implementation of the policy is an important lever for the effectiveness of the LAES policy by favoring lower private transaction costs through relevant support and information diffusion.

Keywords: Local Agri-Environmental Schemes, transaction costs, information diffusion, social networks, intensity of adoption,

JEL codes: D23, O33, Q12, Q28

---

[1] Ph.D candidate, University of Auvergne - Irstea (Institut national de Recherche en Sciences et Technologies pour l'Environnement et l'Agriculture), UMR Métafort, 63178 Aubière.

E-mail : andriambelona85@yahoo.fr Phone no: +336.43.73.13.67

I. Introduction

In France, the implementation of agri-environmental measures aiming at limiting nonpoint source pollution was territorialized in order to support the achievement of the objectives set by the Water Framework Directive. The Local Agri-Environmental Schemes were thus introduced in 2007. Indeed, the AES program implemented in the period 2000-2006 was evaluated as having very limited effects on farmers' practices and water quality. First, farmers mostly chose to contract the less constraining measures, also those having less environmental impact. Second, the participation rate of farmers to agri-environmental schemes in a given area was often too low to induce a significant effect on water quality (AND International, 2008).

These new LAES differ from the previous programs targeting water pollution in two points (Gassiat *et al.*, 2010). First, implementation areas are chosen to match the environmentally relevant scale, such as watersheds or drinking water catchments. Only the farmers whose farmland is located within the boundaries of these areas are eligible to enter the agri-environmental contracts. Second, a local project coordinator is responsible for defining and implementing the agri-environmental program. Project leaders are also in charge of the promotion of agri-environmental schemes to the eligible farmers in the area.

Regarding the contracting process, the LAES are, like the previous program, characterized by five-year contracts. But farmers who want to benefit from a LAES contract may enroll only the eligible part of their farm. To identify eligible parcels of land, they have to carry out an environmental diagnosis of the farm and check the part of their eligible land that matches the water quality preservation zone, according to the project leader zoning. Then, they have to submit a written application along with the eligibility certificate delivered by the project promoter. Among the set of LAES practices suggested by the project leader, those thought to be the most relevant for the farm and to which the farmer wants to apply is stipulated in the application form, recalling the commitments and the corresponding annual payments. The LAES contract is signed when the farmer's application is approved by the Government representative. The transaction costs experienced by farmers during this process are likely to be high.

Yet, due to the voluntary nature of the LAES program, its adoption by farmers is of great importance. A high participation rate is crucial for controlling the problem of surface and groundwater pollution and for limiting nonpoint source pollution from agricultural practices. The condition for LAES' efficiency according to their goal is to achieve local collective dynamics and high level of contracts coverage since nonpoint source pollution presents threshold effects (Dupraz *et al.*, 2007). In other words, what ultimately determines the importance of the agricultural pollution (either nitrate or pesticides) is not the number of farms where pollution may come from, but the surface of farmland where they are used non-optimally. This raises the question of what factors may enhance farmers' participation rate in such a program, and ultimately, what determines the extent of adoption of AES practices.

The main goal of the present paper is to investigate the factors that affect both farmers' adoption of the agri-environmental measures and the extent of adoption in a context of local-scale AES diffusion. More specifically, we intend to suggest a new category of transaction cost determinant which affects farmers' participation to the French LAES program. In doing so, this paper contributes to the development of the literature dealing with the effects of farmers' networks on their decision to uptake environmentally-friendly practices using individual farm households' data on information and advisory networks.

First, on the basis of a micro-economic model of LAES technology uptake, considering individual households' utility maximization objective as the main rational, we take into account the possible existence of a simultaneity problem raised in the identification of the network effects on LAES adoption by considering a dynamic framework (Manski, 2000) and by using simultaneous and two-stage control function methods (Guevara and Ben-Akiva, 2010). Then, existing methodology for analyzing AES adoption determinants is extended to allow for farmers spatial interdependencies in the uptake decision model, and to take into account self-selection bias in the determination of the acreage enrolled in the agri-environmental program by using Heckman model.

The paper is structured as follows: section 2 reviews literature on AES-related costs in order to identify the potential for social networks to overcome these barriers. Section 3 presents a micro-economic setting that allows us to investigate the networks effects on the new LAES technology adoption decision and the extent of adoption. Section 4 is dedicated to the empirical analysis. It describes first the case study, presents the data and some descriptive statistics. Then, the estimation method and the model specification are presented before reporting and discussing estimation results. Finally, section 5 gives some concluding remarks.

II. Private transactions costs and AES contracts adoption

In a number of empirical studies focusing on the determinants of farmers' participation to agri-environmental contracts, the magnitude of the private transaction costs[2] have been identified as one of the main barriers for farmers to enter an agri-environmental voluntary program. The LAES-related transaction can lead to additional costs explaining, among other factors, the range of choices one can observe from farmers' participation to agri-environmental contracts.

In a study conducted in 10 European regions, Mettepenningen *et al.* (2009) show that the observed transaction costs account on average for 14% of the total costs associated to the contract compliance

[2]Costs supported by private actors, here the farmers to whom a five-year LAES contract is proposed.

costs. They could amount to 25% of the contracts payments received by farmers to compensate losses of revenues concomitant to the adoption of more friendly practices. Besides, farmers' perceptions approach used to analyze the determinants of the participation in agri-environnemental contracts also highlight that transaction costs are perceived to be high and therefore constitute one of main barriers to contracts sign-up (Kuhfuss et al., 2012). In the context of the LAES contracts adoption, these transaction costs correspond to the costs supported by farmers (i) when collecting and processing information on the LAES program characteristics, contract requirements, eligibility criteria, fixed per-hectare compensation payment…; (ii) when preparing LAES application (mapping and identifying the surface of plots eligible to be entered in the contract…) and contracting; (iii) when changing practices in line with the contracts requirements and keeping mandatory farm documents…

In France, a study focusing on the determinants of farmers' participation to agri-environmental contracts in the context of a Local Agri-Environmental Scheme in the Poitou-Charentes region highlights the importance of the role played by the local coordinator in the success of the projects (Louis and Rousset, 2010). Their results show that, besides the incidence of the financial compensation provided for the implementation of the measures and the farm characteristics, the diffusion of information by the project leader to farmers has a significant impact on their choice to enter an agri-environmental contract. When farmers were informed directly by the coordinator about the agri-environmental scheme, they were more likely to participate. This result confirms the findings of several other empirical studies conducted on the factors driving farmers' participation to agri-environmental schemes in Europe, which stress the importance of transaction costs, and more particularly, information costs, as constraints to participation (Falconer, 2000; Ducos et al., 2009; Mettepenningen et al., 2009).

Louis and Rousset (2010) also test for an effect of farmers' trust in local organizations involved in the implementation of the agri-environmental project but do not find a significant difference between participant and non-participant farmers in the study area. However, Del Corso and Képhaliacos (2013) and Nguyen *et al.* (2013) suggested a significant role of farmers' trust in implementing agencies, particularly when the implementing agency is a farmers' cooperative, for the participation of farmers to agri-environmental schemes. While these findings relate to the French context, they corroborate the conclusion of other empirical studies conducted in other locations (Polman and Slangen, 2008; Ducos *et al.*, 2009). Lubell (2004) shows further that the existence of trusting relationships between government officials and farmers has a positive effect on the level of participation of farmers to water quality conservation programs in the context of a watershed partnership in Florida. He concludes that the interaction between farmers and local agencies is one important nexus for securing their cooperation.

Accordingly, the diffusion of information by the local coordinator to farmers and the existence of trusting relationships between them are seen to have a positive effect on the level of participation of farmers. First, these links allow farmers to access to information on the AES program (Falconer and Whitby, 1999; Falconer, 2000; Ducos and Dupraz, 2006; Morrison *et al.*, 2008; Polman and Slangen, 2008; Cardona and Lamine, 2010; Kuhfuss *et al.*, 2012). Then, they may overcome the complexity of the contracting process and its administrative tasks (Beckmann *et al.*, 2009; Mettepenningen *et al.*, 2009; Gassiat and Zahm, 2010; Kuhfuss *et al.*, 2012).

III. A theoretical framework

1. A microeconomic model for LAES contract adoption

In line with the transaction costs theory, we assume that the most efficient choice we can observe from the farmers' decision is that which minimizes the production costs of the alternative practices required by the contract settings and the costs related to decision-making and contracting processes. While the costs associated with the production of the alternative practices are supposed to be covered by the fixed per-hectare payments (Ministère de l'Agriculture, 2007), additional transaction costs are not. Thus, in the following model, we are more concerned with analyzing the conditions from which the level of transaction costs will impede contracting to LAES program and to what extent farmers' networks, particularly the existing links with the project leader, may lower these costs.

To analyze farmers' decision to adopt a LAES contract, we follow Vanslembrouck *et al.* (2002) and Dupraz *et al.* (2003) and consider a unitary and representative farm household model in which a single utility function is maximized. We start with the willingness to accept model they proposed and extend it to take account of network effects on transaction costs. We then formulate testable propositions with respect to the influence of farmers' networks on the LAES uptake decision. To integrate non-economic motivations in the decision-making model, farmers' utility function is considered to be defined by multiple criteria characterized by a set of both economic and non-economic decision variables.

<u>The maximization program</u>

Within the local agri-environmental schemes framework, a set of practices farmers may incorporate into the farm production function is offered. The baseline of our model considers that the household's utility is defined over the consumption of (private) marketed goods that results in income π and on the provision of environmental services (s). A farm profit maximizing model is developed in a context of market imperfections, under uncertainty, when the farmer faces the decision to sign-up or not a LAES contract.

Assuming that the farmers' utility is geared by an increasing land profitability derived from land allocation, given the total farm area S, the surface of eligible (to the LAES program) land S_E, the proportion of land s allocated to the LAES practices and the surface s_0 of actual practices, the farm profit can be specified as follows:

$$\pi = s.\overline{G_s} + s_0.\overline{G_{s_0}} - PC_{ss_0} - TC_s + P.s \quad (1)$$

Where $\overline{G_s}$ represents the mid-term gross margin from adopting LAES practices; $\overline{G_{s_0}}$ the average gross margin derived from the farmer's actual practices; PC_{ss_0} the fixed costs associated with the production of private goods and environmental services; P the fixed per-hectare payments of implementing LAES and TC_s the transaction costs associated with the participation to the LAES program.

Let us rewrite the mean gross margin of actual practices as $[p'f(x,Z) - w'x]$; the LAES-related gross margin as $[P.\mathrm{g}(s,Z)]$; and the total production costs PC_{ss_0} as $[r'Z]$. Assuming further that $U(.)$ is increasing, concave and differentiable in its arguments, the maximization problem a farmer solves can thus be written as follows:

$$\underset{\pi,s}{Max}\, U(\pi, s)$$

$$\text{s.t.} \qquad \pi \leq [p'f(x,Z) - w'x] + [P.\mathrm{g}(s,Z) - TC_s(s,X)] - [r'Z] + R_{off} \quad (2)$$

$$\begin{cases} S_E = s + s_0 \\ S_E > 0 \\ S = S_E + S_{NE} \end{cases} \quad (3)$$

Accordingly, the total income π derived from the LAES adoption for any eligible farm household can be split into four components:

$[p'f(x,Z) - w'x]$ is associated with the actual private goods production. This profit is generated by the current production associated with the technology $f(.)$, assumed to be increasing and concave $(f' > 0, f'' < 0)$, the vector p' of the inverse matrix of output-price and the total variable production costs $w'x$ (with x a vector of variable inputs).

$[P.g(s,Z) - TC_s(s,X)]$ corresponds to situation under LAES contract. This income is derived from the multifunctional production technology $g(.)$, assumed to be increasing and concave $(g' > 0)$, $(g'' < 0)$, and determined by the fixed allocated inputs Z and the amount s of eligible land enrolled in the contract; the fixed per-hectare payment P and the total transaction costs. The $TC_s(.)$ function is split in two components: a fixed part (information and decision-making costs) which do not vary with the area entered in the contract[3]; and a variable component occurring during administrative and contracting phases and linked to the activities of preparation of the application, conformity control of practices[4]… Therefore, it is defined by a vector of transaction characteristics (the level of risk and uncertainty surrounding the LAES transaction…) and farm and farmer characteristics X as well as the amount of contracted area s. Besides the $TC_s(.)$ function is postulated to be positive for all eligible farmers (i.e. when $S_E \geq 0$):

---

[3] This category of transaction costs also corresponds to the so-called *ex ante* transaction costs. The two terms are used interchangeably in the remainder of the paper.

[4] These costs are also defined as *ex post* transaction costs later.

$\frac{\partial TC_s(s,X)}{\partial s} \neq 0$; $TC_s(0,X) > 0$

$[r^{'}Z]$ corresponds to the total fixed costs allocated to the joint production of marketed goods and environmental services associated with LAES adoption; Z being the vector of technical production factors including S, the total land under cultivation, assumed to be fixed within the contract duration. r' is the vector of the inverse matrix of fixed inputs price. The last component $[R_{off}]$ is a constant term representing off-farm revenues, assumed to be exogenous.

Transaction costs, information diffusion and social networks effects

In order to explain to what extent farmers' networks, and particularly their relationship with the LAES project leader will affect their decision to uptake LAES contracts, we hypothesize that networks effects stem from a diffusion of information mechanism, leading to (i) a lower level of transaction costs (information and decision-making costs; administrative and contract enforcement costs) supported by farmers and to (ii) an influence in farmers' attitude towards the LAES program.

Formally, let us consider the stock of information I_{it} the farmer i has at the period t of introduction of the LAES program. During the contracting process, farmers engage in information gathering in order to calculate the potential gains from adoption. On the basis of Feder and Slade (1984) development, I_{it} can be written as the sum of the farmer's stock of information from the previous period I_{it-1}, plus the decisive information (A_t), accessed through the mobilization of personal and/or organizational networks, and the "passively acquired information" (M_t):

$$I_{it} = I_{it-1} + A_t + M_t \qquad (4)$$

This yields an increasing and convex function of the costs supported by farmers: $C(I_{it}) = C(I_{it-1}) + C(A_t) + C(M_t)$, where $C(I_{it-1})$ depends on farmers' characteristics (X). While a strictly positive cost $C(A_t) > 0$ which adds to the level of LAES transaction costs is observed when $(A_t) > 0$, it is assumed that M_t acquisition does not cost to farmers. Indeed, it is 'public' information that farmers acquire without a deliberate collection process. In other words, any farmer may benefit from M_t as long as they are exposed to it. Therefore, the level of $C(I_{it})$ will be defined by the variation of $C(A_t)$ as:

$$C(I_{it}) \cong C(A_t) = \mathrm{C}(h(R_{it})) \quad ; \quad \text{with} \quad h' > 0;\ h'' < 0 \qquad (5)$$

$h(.)$ being a concave function of information diffusion through farmers' social networks R_{it} at the beginning of the decision-making process. Assuming c'as the vector of the inverse matrix of the costs associated to A_t, it yields: $C(I_{it}) = c'A_t = c'h(R_{it})$. Then, hereafter, we consider the level of public information M_t increasing with the adoption pattern in the farm neighborhood, M_t is defined as:

$$M_t = k(N_{it}) \quad ; \quad \text{with} \quad k' > 0;\ k'' < 0 \qquad (6)$$

where N_{it} is the cumulative proportion of LAES adopters in the neighborhood of a farm at the beginning of the decision-making process. On the basis of this extension, the farmer's utility function is now affected: first, by the level of transaction costs which is decreasing with the information flow the farmer gets in response to the mobilization of his social networks: $TC_s(h(R_{it})) \geq 0\,; h' > 0;\ h'' < 0$, and second, by the farmer's exposition to LAES public information as defined in (6).

The adoption decision rule

Rewriting the farmer's maximization program in (2) yields:

$$\underset{\pi,s}{Max}\, U(\pi, s)$$

$$\text{s.t.} \qquad \pi \leq [p'f(x,Z) - w'x] + [P.g(s,Z) - TC_s[c'h(R,s),X)] - [r'Z] + R_{off} \qquad (2^*)$$

$$\begin{cases} S_E = s + s_0;\ S = S_E + S_{NE} \\ s \geq 0 \\ I_{it} = I_{it-1} + A_t + M_t \\ A_t > 0 \end{cases} \qquad (3^*)$$

The first-order conditions yield:

$$\frac{U}{x} = U_\pi(pf'(x,Z) - w) = 0 \qquad (7)$$

$$\frac{U}{s} = U_s\, g'(s,Z) + U_\pi(P.g'(s,Z) - TC_s{}'(c.h(R,s).h'(R,s)) = 0 \qquad (8)$$

From (8), we can identify 3 possible solutions regarding the transaction costs function minimization:

$U_\pi(pf'(x,Z) - w) < 0$ and $U_s\, g'(s,Z) + U_\pi(P.g'(s,Z) - TC'(c.h(R,s).h'(R,s)) < 0$: no adoption

$U_\pi(pf'(x,Z) - w) = 0$ and $U_s\, g'(s,Z) + U_\pi(P.g'(s,Z) - TC'(c.h(R,s).h'(R,s)) = 0$: adoption

$U_\pi(pf'(x,Z) - w) < 0$ and $U_s\, g'(s,Z) + U_\pi(P.g'(s,Z) - TC'(c.h(R,s).h'(R,s)) = 0$:no adoption, unless the farmer' sensitivity towards environmental preservation and the LAES program is high enough to compensate marginal losses of revenues. In such a case, the farmer's social networks may play an important role in the formulation of the farmer's decision.

The solution of the microeconomic model defines the process by which a farm household's decision is driven in the context of LAES diffusion. Hence, three propositions are made:

Proposition 1: Farmers with higher level of interactions with the project leader will access to more private and decisive information, have limited transaction costs, and thus have a higher probability to adopt rapidly.

Proposition 2: Farmers with higher level of personal or social links which would be favorable with the LAES program will access to more private and decisive information, have limited transaction costs, and thus have a higher probability to adopt rapidly.

Proposition 3: Farmers being in the vicinity of a high LAES adoption rate area will be exposed to more information on the LAES contract implementation; they will learn more and develop knowledge about LAES by neighbors and colleagues with whom they share subjective norms; and will respond accordingly.

IV. Empirical application: the adoption of LAES contracts aiming at preserving water quality at the water basin level

1. The case study

In order to test the effect of networks membership variables on the "LAES for water" contract adoption, a sample of eligible farmers for the alternative practices required by LAES contracts have been surveyed in Auvergne and Poitou-Charentes regions. More precisely, fieldwork has been undertaken in three LAES territories, mostly characterized by livestock farming and crop systems: the *Centre-Ouest* and *Boutonne Amont* catchments in the Poitou-Charentes region and the *Vallée de la Veyre* basin in Auvergne. In the *Vallée de la Veyre* LAES territory, the program was implemented since 2008 and eligible farmers had three years, namely during 2008 or 2009 or 2010, to decide to enter the program. The *Centre-Ouest* project has begun in 2010 whereas that of the *Boutonne Amont* catchment was since 2013. Like in Auvergne, the eligible farmers in the study areas in Poitou-Charentes had also three years to enter the LAES program. The three projects studied here are coordinated and implemented by local drinking water suppliers. They aimed at limiting nonpoint source pollution from agricultural sources in order to preserve water quality at the water basin or the drinking water catchment level. Farmers are mostly encouraged to limit the use of fertilizers and pesticides, during five years, by adopting alternative practices. Specifically, measures such as the maintenance of practices on meadows; the introduction of a new crop in the crop rotation systems; the use of mechanic and alternative practices for weed control instead of pesticides… are proposed to be contracted. Within these three different territories, we interviewed a sample of 166 eligible breeders and cereal farmers, 69% of whom (115) had enrolled in LAES contract. Farmers were drawn randomly from the project leader catalog recording all the farmers operating in the basin. This sample is representative of the population of eligible farmers in each LAES territory. Interviews were conducted during the spring of 2015 (from April to July). Among the 166 eligible farmers, 30% was interviewed directly by telephone, 56% through face to face interviews and 14% participated in on-line survey.

To select for relevant networks variables, we conducted a review of the empirical literature analyzing the impact of networks on the adoption of technical innovations in agriculture as very few studies have analyzed the role of farmers' networks in the literature dealing with agri-environmental contracts adoption determinants. These studies have focused mostly on the links existing between farmers and the project leader (Wilson, 1997; Polman and Slangen, 2008; Peerlings and Polman, 2009, Louis and

Rousset, 2010) and to a lesser extent on the role of farmers' participation in economic organizations, including farmers' cooperatives (Polman and Slangen, 2008; Peerlings and Polman, 2009; Giovanopoulou *et al.*, 2011, Espinosa-Goded *et al.,* 2013). As we aim at investigating the role of the whole information and advisory networks mobilized by farmers during the LAES implementation, broadening the review to the innovation technology diffusion literature was useful. Within this latter, most of the studies, including the pioneer ones (eg. (Foster and Rosenzweig, 1995)) used village-level network proxies such as the average village adoption rate to measure the impact of networks on the adoption of new technologies. They assumed that (i) all farmers in the village inter-influence in the same way and that (ii) learning takes place along geographical lines. However this approach was blamed for not being necessarily correct, particularly in villages or territories characterized by social or cultural stratification and where heterogeneity with respect to farmers' unobserved characteristics or other institutional factors may be of importance. In our case, we take account of these reviews and follow eg. Bandiera and Rasul (2006) and Lubell and Fulton (2007) in using collected data on individual social network, namely information and advisory networks, to test social networks effects. In this sense, we assume that farmers did not learn from all farmers in the LAES territory, but may be more influenced by smaller networks formed on a personal basis (De Weerdt and Dercon, 2006) and that they respond more to network partners that are similar to them (Conley and Udry, 2001; Munshi, 2004). To identify farmers' small networks which could be relevant for the LAES adoption study, we referred to Darré *et al.* (1989)'s small networks specification: informational and advisory networks, technical discussion circles and networks of social influence.

As a first stage, the questionnaire was field tested with five eligible farmers, and revisions were made to include what they expressed as more relevant information and advisory networks. The questionnaire gathered data regarding four main topics: (i) network and group membership data with special interest in the networks mobilized to access information; (ii) perceptions and enrolment in LAES contract; (iii) basic farm and (iv) farmer socio-economic characteristics. In addition to the data collected through the questionnaire, the amount of the acreage enrolled by participants was obtained from the Puy-de-Dôme and Deux-Sèvres agricultural offices. As we aim at understanding the role of the information diffusion in individual farmers' social networks, i.e how farmers access to information on LAES contracts characteristics and innovations until they decide to adopt or not, we have identified three categories of interpersonal networks from which farmers learn about and within which they discuss the LAES program characteristics and incentives. This networks characterization was done through their answers to the question "*To whom do you most often turn (firstly, then, and eventually) for information or for advice on…"*. In this question, we as asked farmers to name a maximum of three information or advisory network (personal links or more formal ones) within a set of possible links (obtained through the phase of test). According to the specificity of the information need, either administrative or technical, it appears that the networks farmers tend to mobilize are mainly those of the project leader structure, the cooperatives and political discussion circles such as farmers' unions (Table 1).

Table 1. Farmers' information/advisory networks in the frame of the LAES implementation[5]

	Networks	Adopters (n_1= 115)	Non adopters (n_2= 51)
Before contracting (*ex ante* TC and attitude towards the LAES contract)	LAES Project leader	66 (57.39%)	20 (39.22%)
	Cooperative's technical advisor	39 (33.91%)	14 (27.47%)
	Political circle (farmers' unions…)	17 (14.78%)	24 (47.06%)
	Informed colleagues	15 (13.04%)	07 (13.73%)
	Other (neighbors, friends…)	25 (21.74%)	12 (23.53%)
After contracting (*ex post* TC and opinion on what is being experienced)	LAES Project leader	15 (13.04%)	
	Cooperative's technical advisor	64 (55.65%)	
	Political circle (farmers' unions…)	59 (64.84%)	
	Informed colleagues	35 (31.25%)	
	Other (neighbors, friends…)	24 (20.87%)	

Among the category of networks mobilized by farmers to access to decisive information, the LAES project coordinator is the structure responsible for the LAES program implementation and its promotion to the eligible farmers. This link is mostly activated to access to information with respect to the program characteristics and its possible evolution after the five-year contract; to learn more about the set of measures proposed and the related payments; to check the eligible surface of the farm and eligible plots location. Further, the project leader is also often asked about the possible renegotiation of the contract… Farmers' cooperatives and more specifically farmers' private technical advisors appears also to be a relevant source of information. They are mobilized during the decision-making process to estimate the potential costs and benefits associated with each set of practices regarding the farm specificity. Their support is seen to be of great importance and is perceived as a mean of risk-sharing, particularly in case of shocks. Farmers' involvement into farmers' unions appears to favor access to information even if the information content mostly goes against the LAES policy promotion. Indeed, some of these structures exert important lobbies in order to reach, since the design of the policy, the least restrictive conditionality to which farmers have to comply with to access to subsidies. Informed colleagues are farmers' colleagues involved in farmer technical groups (such as a CUMA[6], a

[5] Percentages in the table do not add up to 100 because farmers were asked to name up to three personal links.

[6] CUMA (Coopérative d'Utilisation de Matériel Agricole)

cereal producers group, or an irrigators association) who are well-informed: about the contracting process as they have already contracted; about the practices conformity control process as they have already experienced a control; about the implementation of a particular LAES measure as they have already performed and integrated it on their farm production system… Finally, some farmers also access to information through discussion with their neighbors, who are most often their friends or farmers with whom they have somewhat good relationships. Due to the geographic proximity induced by the territorialization of the LAES program and the rather homogenous characteristics of neighboring farms, farmers' exposition to areas where the LAES adoption rate is high will have lower information costs and may be more influenced and inclined to participate to the program.

According to the Table 1, it appears that our subsamples of adopters and non-adopters do not talk most frequently about LAES program and their adoption decision within neither the same informational circles nor the same networks of social influence. While the adopters subsample tends to search for or to get "relevant information"[7] on the LAES device and its profitability, given the farm characteristics and farmers' attitude, from the LAES project leader and their technical advisor, non-adopters are rather informed within political structures such as farmer union. However, even if these informational and advisory networks have provided for what is considered to be "relevant information" for the farmer, we can suggest that the effects of each of these networks may be different. From this perspective, it can be assumed that the impact of a given informational or advisory network will depend on its own efficacy with respect to the LAES program diffusion and the capacity of a farmer to mobilize efficacy networks. Accordingly, networks efficacy has to be well-defined in order to refine the assumptions made regarding their effects on the LAES adoption choice. In order to test econometrically the effect of farmers' networks in the LAES contracting decision, next sections present the econometric models and models specification.

2. The econometric models

The farmer decision to adopt a LAES contract can be derived from a latent variable U^* corresponding to the net benefit he/she can expect from his/her participation to the contract. This decision is first modelled as a discrete choice as the farmer will adopt when the expected benefit is positive ($U^* \geq 0$) and will be a non-adopter when ($U^* < 0$). Second, a selection model is performed to investigate the determinants of the acreage entered in the program given that the farmer has decided to adopt.

At the LAES territory level, neighboring farms may exhibit similar characteristics or preferences, leading to spatial interdependencies in the observed decision. Ignoring this effect in the econometric model can lead to biased estimates. Accordingly, we extend the basic random utility model setting

[7] The term "relevant information" was not defined in the questionnaire so that the farmer can answer with a minimum bias, according to what is considered as relevant information to him/her. Only the different stages of the LAES diffusion and implementation process was noticed. This approach allowed us to get information concerning the mobilized networks at each level of the LAES adoption process.

(McFadden, 1974; Train, 2009) by relaxing the independence assumption across households[8], allowing farmers to be spatially interdependent. We allow for a farm household's characteristics to be spatially dependent on those of its neighboring farms by estimating a spatial probit model. More precisely, a spatial error model (SEM) accounting for spatial autocorrelation of the model error terms is estimated in that the presence of spatial dependence in the observed portion of the farmers' utility is excluded. In line with our microeconomic model, a farmer's decision to adopt a contract is not subject to his/her neighbors' characteristics but guided solely by the net benefit he/she expect from his/her participation to the program. Given that the net benefit depends on the farm and farmer characteristics and on farmers' networks, the presence of a strategic interaction between neighboring farms in their choice regarding the adoption of a LAES contract is left out.

Spatial probit model for the LAES contract adoption

Recall that our main hypothesis is that by reducing private transaction costs (through the diffusion of information and the development of trust) and by influencing farmers' attitude toward the LAES contract and its characteristics, farmers' networks will affect the LAES adoption decision. By taking into account farmers' decision interdependencies in the decision rule, the adoption equation can be written as follows:

$$\begin{cases} LAES_i = \beta_1 R_i + \delta_1 X_i + \varepsilon_i \\ \varepsilon_i = \lambda W \varepsilon_i + v_i \end{cases} \qquad (9)$$

$$R_i = \theta Z_i + \delta_2 X_i + \mu_i \qquad (10)$$

where $LAES_i$ is the observed adoption decision for each farm household (i = 1, ...,N) in the sample. Exploratory variables include R_i , the $N \times K$ matrix of network variables and X_i a $N \times K$ matrix of other farmers' specific characteristics and control variables. ε_i is the vector of error terms of the model, including an i.i.d. part (v_i) and a spatially correlated part ($\lambda W \varepsilon_i$). W is a non-negative spatial weight matrix. The definition of the "neighborhood" and the spatial weight matrix W is based on geographic proximity, which may be particularly relevant in the case of agri-environmental practices information diffusion which is not subject to mass media or other marketing communication (Case, 1992). Therefore, we consider geographic proximity to define our spatial weight matrix and assume, following Tobler (1970: 236), that "Everything is related to everything else, but near things are more related than distant things". For example, it can be considered that farms' characteristics are more similar within a more restricted area but become more and more heterogeneous when the area considered is larger. Exchanges and influence of more distant neighbors on a given farmer's attitude is thus dying out. Accordingly, the W matrix is specified as an inverse distance matrix (1/d) calculated

[8] The basic RUM (Train, 2009) considers agents as heterogeneous but independent, as the systematic part in their preferences are modeled by the deterministic component of the random utility but their decisions are unaffected by choices made by others.

from the easting and northing coordinates of each farm's location. The distance limit used to calculate the weighting matrix is 10km to ensure that all neighbors are well accounted in the calculation. Indeed, in our study areas, the distance between two plots belonging to a farmer can be up to 10km. Put differently, farmers' plots can be located up to 10km from the farm office. If two farms are distant more than 10km: $\lim_{d \to +\infty} w_{ij} = 0$. The geographical proximity is computed according the inverse distance formula. The computation of the W was performed using the spatial probit package for R.

Heckman selection model for the LAES adoption intensity

The adoption intensity is estimated via the Heckman (1979) selection model to correct bias from using the non-random selected sample of LAES contractors. Indeed, the amount of acreage entered in LAES contracts cannot be observed for LAES non adopters. Moreover, if factors influencing the adoption decision affect the extent of adoption, there may be significant selection bias. Yet, our objective is to analyze the role of networks variables on both the LAES adoption rate and the extent of adoption. Thus, in a first stage, the propensity to contract LAES is estimated. A transformation of the predicted individual probabilities from this first estimation is then used as an additional exploratory variable to correct for self-selection in the second stage, when estimating the adoption intensity.

The second model is specified as follows:

$$\begin{cases} \textbf{(A)} \boldsymbol{Propensity\ to\ contract}: & \boldsymbol{LAES_i = \beta_4 R_i + \delta_4 X_i + \epsilon_i} \\ \textbf{(B)} \boldsymbol{Acreage\ enrolled}: & \boldsymbol{LAESAcreage_i = \beta_3 R_i + \delta_3 X_i + u_i} \end{cases} \qquad \textbf{(11)}$$

where X_i and R_i are exogenous vectors of regressors; β and δ vectors of parameters to be estimated; ϵ and u are error terms. From (A), the conditional expectation of $LAESAcreage\ enrolled$ can be specified as in(B) where the $LAESAcreage_i^*$ becomes a latent variable defined by the equation(A) as:

$$\begin{cases} LAESAcreage_i \ is\ observable & if\ LAES_i = 1 \\ LAESAcreage_i \ is\ not\ observed & if\ LAES_i = 0 \end{cases}$$

The conditional expectation of the intensity of LAES adoption given the farmer contracts is then:

$$E(LAESAcreage_i | R_i, X_i, LAES_i = 1) = \beta_3 R_i + \delta_3 X_i + u_i + E(u_i | R_i, X_i, LAES_i = 1)$$

Assuming that the error terms ϵ and u follow respectively $N(0;1)$ and $N(0;\sigma)$, i.e. they are jointly normal, we have: $E(LAESAcreage_i | R_i, X_i, LAES_i = 1) = \beta_3 R_i + \delta_3 X_i + u_i + \rho\sigma\lambda(Z\gamma)$

where ρ is the correlation between unobserved determinants of propensity to contract ϵ_i and unobserved determinants of the acreage enrolled u_i. σ is the standard deviation of u_i, and λ is the inverse Mills ratio evaluated at $Z\gamma$. By replacing γ with probit estimates from the first stage (A), the λ term is constructed. The $Acreage\ enrolled$ equation (B) is then estimated with OLS, the λ term being added as an additional exploratory variable.

3. Models specification

In this section, the econometric specification used to explain the effects of farmers' networks and neighborhood in their LAES adoption decision are presented.

Definition of network variables and expected signs

On the basis of the descriptive statistics on farmers' networks presented in Table 2, we can re-write the R_i vector of farmers' informational and advisory networks as follows:

$$\boldsymbol{R_i = f(PL_i, Coop_i, Union_i, FGroup_i, Neighb_i)} \qquad \textbf{(12)}$$

R_i includes first, the existing links between farmers and the project leader (PL_i) measured by the average annual frequency of interactions between the LAES project coordinator and farmers. The farmer's technical advisor support ($Coop_i$) is used to capture the effect of technical advisory networks. Farmers' technical advisors are from agricultural organizations. These organizations may be farmers' cooperatives or private dealers ("négociants") who are carrying on the same set of activities as cooperatives. As this network appears to serve not only adopters but also non-adopters respondents, capturing its effect through its orientation and through its involvement in the LAES diffusion process may serve as a better predictor. Then, farmers' political discussion circle, captured by the level of involvement in farm unions ($Union_i$) whose effect may be negative or positive according to their general opinion on agri-environmental systems (Brun and Chabé-Ferret, 2014) and particularly on the LAES program. Farmers' colleagues influence is captured through involvement in farm groups ($FGroup_i$). As it was mentioned earlier, these farm groups are characterized with more homophilous relations of their members due to homogeneity with regard to some farm characteristics and preferences. Finally, neighborhood influence through information diffusion, direct exchanges or observations is measured spatially through the $Neighb_i$ variable. This latter captures local social networks effects as it represents the cumulative proportion of LAES adopters within a 10km radius[9] around the farm. In order to avoid simultaneity problem in the determination of the $Neighb_i$ effect, we follow Manski (2000) approach by assuming a dynamic adoption framework. Accordingly, only previous adopters are accounted as likely to influence a farmer's decision to adopt in the next period[10]. Table 2 summarizes the expected effects of each network variables on the two latent variables reflecting farmers' utility.

---

[9] This distance relies also on the assumption used earlier to compute the distance matrix W for farms neighborhood.

[10] Recall that the LAES program allows farmers to decide to sign-up within a period of three years.

Table 2. Social networks variables and expected effects on the probability and the intensity of LAES adoption

		Description	Expected effect on: $TC_s(.)$	$U_{\pi,s}$	s^*
R_i	PL_i	Measures the average annual frequency of interactions between the local project leader and farmers during the implementation phases of the LAES project	-	+	+
	$Coop_i$	Measures the influence of being supported by technical advisor whose organization was involved in the LAES program definition process	-	+	+
	$FGroup_i$	Measures farmers' implication in local farmer technical groups	-	+/-	+/-
	$Union_i$	Measures farmers' personal involvement in farmer union	-	+/-	?
	$Neighb_i$	Measures the proportion of adopters in the neighborhood, captures social interactions within neighboring farms	-	+/-	?

Definition of control variables

To identify the set of control variables, we refer to the literature analyzing farmers' participation in agri-environmental contracts, taking account of farmers transaction costs (see Defrancesco *et al.* (2008) for a review and Lastra-Bravo *et al.* (2015) for a qualitative meta-analysis). Within this category of literature, independent variables which influence the adoption of an agri-environmental practice can be classified in four main categories: farm structure and farm household income, farmers' characteristics, farmers' attitude towards the environment and the program, including personal attitude and subjective norms, and contextual factors referring to the local environment characteristics. In our case, we assume variables influencing the probability to uptake LAES contract may also affect the intensity of adoption. Therefore, we tested alternative specifications of probit and heckman models in order to find the most reliable specifications according to the AIC and BIC criteria (Gujarati, 1995). We also ensure that the number of variables included in the final specifications will not overload model degrees of freedom. In addition to farmers' networks variables which are supposed to affect transaction costs associated with the LAES decision-making and implementation as well as farmers' attitude towards the program, we introduce predictors corresponding to the farm and farmers' characteristics and contextual factors.

Many authors have considered farm size to be one of the most important farm's characteristics affecting AES adoption, but results are not always consistent with regard to its effect (positive or negative) on the participation decision (Defrancesco *et al.*, 2008). To control for both the farm size and the eligible area effects, we use the surface of non-eligible area (NonEligArea) to capture both the farm size and the proportion of eligible land effects. Non-eligible area represents the difference between the two variables and is expected to affect in a negative sense the probability to participate in LAES program. Farmers' participation in off-farm employment ($\mathrm{OffActiv}$) is also used and expected to have positive or negative effect on the adoption decision. This expectation stems from the assumption that when farmers have additional income through their participation in off-farm activities, they are more willing to participate in AES because the decision to adopt new practices becomes less risky as to its potential impact on the farm households revenues (Polman and Slangen, 2008; Peerlings and Polman, 2009). Inversely, it can be assumed that the participation in off-farm employment may discourage AES adoption due to additional time required by the AES implementation, suggesting that the LAES payments do not offset the foregone off-farm income. Finally, the effect of the main type of farmland cover[11], which by extension can be approximated to the farm orientation, is also tested through the surface of grassland ($\mathrm{Grassland}$). This variable plays a significant role in the prediction of an AES contract uptake, as shown by Wilson and Hart (2000) and Barreiro-Hurlé *et al.* (2010). In their results, these authors found that grassland farms were more likely to adopt an AES than arable farms. In our case study, we expect a similar effect to the extent that grassland farms are rather extensive. They exhibit an average livestock density equals to 0.867, much lower than LAES requirements.

Regarding farmers' characteristics, farmers' age (Age) appears in most studies to play a significant role in AES uptake to the extent that young farmers seem to be more willing to take risks, more open to change, and are therefore more inclined to enter AES contracts (Bonnieux *et al.*, 1998; Wynn *et al.*, 2001). In line with these authors, we include this variable in our model specification and expect a negative effect on the LAES contract adoption. Then, to account for farmers' experiment, in terms of farm adaptation flexibility and personal attitude towards the implementation of agri-environmental contracts, we follow Drake *et al.* (1999) and Vanslembrouck *et al.* (2002) and use farmers' previous participation in AES contracts variable ($\mathrm{AESexpe}$) to predict the participation decision. This variable is expected to have positive effect on the participation decision. Finally, we include LAES territory dummy variables ($\mathrm{TerrFES}, \mathrm{TerrFEV}, \mathrm{TerrFEB}$) to control for the effect of the institutional environment framing the implementation of the LAES program in each study area. These dummy variables may also capture the local dynamics with regard to water preservation policies, farmers' previous involvement in such programs… To avoid the problem of multicolinearity, we use the $\mathrm{TerrFEB}$ dummy as reference for the interpretation of the results. Table 3 (appendix 1) presents some descriptive statistics on the exploratory variables used in the final econometric specification.

[11] The LAES measures which are proposed to farmers are representative of the main land cover in the project territory. Farmers' eligibility to a given set of measures depends, among other criteria, on the type of the actual eligible farmland cover.

V. Main results

1. Probit estimation of farmers' decision to adopt a LAES contract

The first purpose of this paper is to identify whether farmers' social and spatial networks impact farmers' decision, and if so, what kind of network is more favorable to their participation in the agri-environmental measures. Then, in a second time, we analyze what type of networks does affect the adoption intensity. To investigate the first question, two empirical models are estimated: a simple bivariate probit model and a spatial probit model that allows for considering the spatial dependence effect between farmers. Before estimating these models, we check for a possible endogeneity of the (PL_i) while other networks regressors are assumed to be orthogonal with ε_i.

Testing for the endogeneity of the LAES project leader network

Endogeneity is a classic methodological concern in econometric. Antolín *et al.* (2014) give an overview of methods developed to tackle this issue in the case of nonlinear discrete choice models. This problem arises when one or more explanatory variables are correlated with the unobserved factors of the model, leading to biased and inconsistent parameter estimates. This bias may surface when we have simultaneous determination, omitted attributes, or errors in variables… In our case, we can suspect the (PL_i) variable to be endogenous through reverse causality as most of the eligible farmers are more likely to contact the coordinating officer in case of information need regarding the LAES program, its characteristics and implementation guidelines. So, the causality would be from the effective participation to LAES contract (or the intention to participate) to the development of links with the project coordinator, with a positive sign. To check empirically for the endogeneity of (PL_i), we use the control function method (Guevara-Cue, 2010), especially suitable when the problem occurs at the level of each observation, in contrast to the BLP correction (Berry *et al.*, 1995; Berry *et al.*, 2004) which works well when endogeneity occurs at market-level or at network reference groups level. This is to estimate equation (9) by introducing the predicted probabilities $(\widehat{\mu_i})$ of the (PL_i) equation (10) estimated with OLS, as an additional explanatory variable. To define instrumental variables, we need variables that are correlated with the strength of links between farmers and the LAES project coordinator but do not directly predict the propensity to uptake a LAES contract. We hypothesize that the farm's water needs for the farm production activity may be a good instrument as it may enhance the probability for a farmer to have stronger links with the local water supplier, without directly affecting his/her decision to uptake an agri-environmental contract. Distance from farm location to the closest water catchment point and whether farmer has an irrigated land were used as instruments. Table 4 (appendix 2) gives the results of the two-stage control-function method (i) as well as the simultaneous ivprobit model (iii). As the estimated error term $(\widehat{\mu_i})$ is not significantly different from zero, in both models, the null hypothesis of the PL_i orthogonality cannot be rejected: PL_i_res $(\widehat{\mu_i})$ significance (i) and Wald test p-value (iii). A second test is that of overidentifying restrictions. This test allows checking for the null hypothesis of validity of the instruments. According to the Amemiya-Lee-Newey's test, we cannot reject the null hypothesis that the chosen instruments are valid, that they are uncorrelated with the error term in the second stage of the orthogonality test.

Spatial probit estimation of the farmers' decision to adopt a LAES contract

In a first time, let us assume that the latent variable (U^*) is distributed according to a normal cumulative function. The errors are assumed to be independently and identically distributed. In a second time, this independence of error terms distribution is relaxed to allow for individual spatial interdependencies. To estimate the spatial probit models, we use the Markov Chain Monte Carlo (MCMC) method, which relies on Bayesian statistical techniques, following LeSage and Pace (2009). This method is more flexible and more suited for estimating models with small samples, whereas McMillen's estimation procedure relies on asymptotic properties and therefore requires large sample sizes to be valid (LeSage, 2000). Our first empirical results are presented in Table 5 (appendix 3). As it is presented, the SEM model exhibits positive and significant value of the spatial autocorrelation parameter (λ=1.25 at 1% level), suggesting a spatial diffusion mechanism in farmers' characteristics affecting their decision.

We find significant positive and strong effects of our two first social networks variables (PL_i) and ($Coop_i$), in line with our expected sign. Moreover, all the network variables' parameters are significantly different from zero in the a-spatial and the spatial models. Regarding the influence of each of them on the LAES adoption, the most important factor is the farmer's technical advisor opinion and support towards the LAES program ($Coop_i$). The result suggests that a farmer who benefits from technical advice from a "cooperative" that is involved in the LAES program will have a 23% higher probability of adopting the LAES. While participation in an economic organization was seen to influence in a different way or no significant, in our result, it exhibits a positive and strong impact on the adoption of agri-environmental practices if more informed about the nature of the measures that are proposed to farmers, then encouraging and supporting their adoption. Otherwise, this impact is likely to be negative, as it is revealed in the extent of adoption test (see Table 6, appendix 4), more particularly, when using a "membership in technical farm group" variable ($FGroup_i$). Anyway, being supported by an agricultural structure who has involved in the implementation of the program is of importance for the effectiveness of the policy. The next most important factor is the existence of strong links with the project leader, increasing the adoption probability by 8%, corresponding to what have been suggested in the literature. However, participation in a farmer union, seen as another way to access to and exchange information, decreases this probability. More precisely, a farmer who talks and discusses LAES program more often within this group has a 5.03 times lower probability to adopt the program compared to a farmer who has discussed about LAES in another circle. Brun and Chabé-Ferret (2014) suggested that the effect of this variable depends on the farm union orientation and general attitude/support towards the program lean on implementation. In our case, the leading farmer unions tend to be those who hinder the adoption of more constraining and more effective LAES practices. Being an informational channel mobilized by some farmers, this network appears clearly to be conflicting and in competition with that of the project leader. Finally, the results highlight the presence of positive and significant neighborhood effects within close farms, suggesting the existence of information diffusion, exchanges and beliefs updating with respect to the LAES benefits and costs. While the magnitude of the marginal effect of this variable on the probability for the farmer to sign-up a LAES contract is not very significant (+0.59%), farm neighborhood appears to be a communication channel on which the project leader can lean to strengthen LAES diffusion and improve adoption rate.

Regarding the other factors affecting the farmer's decision to uptake a LAES contract, our result corroborates the findings of many empirical studies which stress that old farmers are less willing to take risks are therefore more inclined to enter AES contracts (Bonnieux *et al.*, 1998; Wynn *et al.*, 2001). We also argued that they are unlikely to evolve their practices due to difficulty to access to information and resources needed to overcome risks and uncertainty perceptions. Moreover, our findings concerning the positive effect of having already participated in previous agri-environnemental programs confirm the results of many empirical papers. In our case, having experienced at least an agri-environmental contract in previous campaign leads to 19% higher probability to sign-up a LAES contract. This supports the fact that the farmer has developed knowledge and skills on the implementation of the agri-environmental practices, lowering the level of transaction costs he/she has to support in the future. Finally, we note that the adoption of LAES contract is about 53% more favorable in the *Centre Ouest* basin (compared with in the *Boutonne amont* basin) and about 33% higher in the *Vallée de la Veyre*. On the basis of our economic model and the literature adopting a perspective of transaction costs in the analysis of the determinants of AES uptake, we explain this result by the quality of the project animation and promotion, namely by the project leader, but also by the characteristics of the local context framing the implementation of the program. These characteristics may include informal institutions' characteristics such as social norms; actors' motivations to cooperate and to develop collaborative relationships for the preservation of the water quality; the history and the results of any previous policies (that were linked to the farm activity or whose recipients were farmers) that may have decline farmers' confidence to local organizations or government agencies...

2. Farmers' networks effects on the extent of LAES adoption

The empirical results regarding the extent of adoption confirm the existence and the correction of a selection bias (IMR significant at 1% level, Table 6). This supports the use of a selection model in estimating factors influencing LAES adoption intensity instead of a simple Tobit model. Indeed, when factors determining the amount of acreage entered in the LAES are also those which affect the probability to adopt a LAES contract, as it is the case for some exploratory variables (Grassland, AESExpe, $Coop_i$…), selection bias has to be controlled. The condition that a positive answer to the contracting choice must exist in order to observe the intensity of adoption is a first dominance condition.

As it is presented in Table 6 (appendix 4), only farmers' cooperatives and technical groups have significant effect on the propensity to enter more or less surface in the LAES program. They appear to be the main networks mobilized by farmer in the *ex ante* and the *ex post* contracting process. While farmers' cooperatives affect, positively, both adoption and extent of adoption decisions, the effects of technical group membership are only significant *ex post* and go in an opposite direction. Farmers' economic organizations play a crucial role in limiting both fixed and variable transaction costs by advising farmers on the most relevant practices as to their farm orientation, whereas membership in farmers' groups tends to reduce the surface of eligible land that the farmer is willing to enroll in the LAES program. Put differently, the latter allows farmers to exchange and develop technical knowledge and know-how on the LAES practices, thus reduce uncertainty. However, the economic constraints linked to the high level of asset specificity (specific machinery, changes in the crop patterns…) of the LAES proposed to the category of farm belonging to the farm groups analyzed in this study (cereal producers group, irrigators association…) may not be enough to reduce the related transaction costs.

Then, the extent of LAES adoption is also influenced by the proportion of eligible land with respect to the total farm area. The positive influence of this variable is in line with the adoption behavior suggesting that the more the part of eligible area in the farm is, the higher is farmers' propensity to invest in new agri-environmental practices due to economies of scale with regard to the total fixed production and transaction costs. This finding corroborates our hypothesis assuming that if only a trivial part of the farm is eligible to be entered in the contract, farmers will act negatively or indifferently towards the program in the name of a minimization costs strategy. Then, as in the adoption decision model, farmers' age also has negative effect on the surface entered in a LAES program. Regarding the farmer's awareness on the problem of water quality degradation in a territory and the participation in off-farm activity, these variables affect the probability for a farmer to sign-up a LAES contract, but do not influence the intensity of the choice. Finally, as in the binary choice model, the *Vallée de la Veyre* and *Centre Ouest* projects exhibit again more incentives for farmers to enroll more land in the LAES contract compared to the *Boutonne amont* project.

VI. Concluding remarks

By using specific data on farmers' AES-related information and advisory networks, this study can be considered as a unified work on the effects of farmers' social networks in AES contract adoption. Indeed, it integrates and confirms the role of the existing relationships between the AES local agency and farmers (Lubell and Fulton, 2007; Polman and Slangen, 2008; Peerlings and Polman, 2009), the importance of farm neighborhood (Kephaliacos and Ridier, 2007; Defrancesco *et al.*, 2008; Allaire *et al.*, 2009), the influence of farmers' unions (Brun and Chabé-Ferret, 2014) and groups or cooperatives (Barreiro-Hurlé *et al.*, 2010; Del Corso and Képhaliacos, 2013; Nguyen *et al.*, 2013) on famers' transaction costs and attitude towards the uptake of an AES contract.

We have shown in this analysis what AES-relevant information and advisory networks may be, what role they play, and how do they affect farmers' decision to uptake a LAES contract. Indeed, the different networks identified in this study affect significantly and in a different way the probability of LAES contract sign-up. They also impact the extent of adoption of the contract, measured by the surface of eligible lands entered in the program. The role of the LAES project leaders in the diffusion of information to the famers was confirmed in this study. Their role in the mobilization of local partners, namely agricultural structures such as farmers' cooperatives, in the LAES implementation process was also of great importance for the effectiveness of the policy. Indeed, by providing for positive and significant technical support to eligible farmers, the transaction costs linked to the adoption process are reduced. This category of network appears therefore to act in complementarity with the project leader's diffusion channel, by lowering the information costs linked to the decision-making process and by reducing uncertainty and risks perceptions on the LAES practices.

Although the conflicting results identified in the literature dealing with the role played by economic organizations in the decision to adopt agri-environmental contracts, we suggest that farmers' membership in economic organizations may be of importance, as they may favor access to information and allow farmers to benefit from valuable technical advice, not only when determining the adoption decision but also and especially when predicting the optimal eligible surface to enter in the program. However, with regard to the LAES promotion and ultimately for the effectiveness of the program, it falls to the project leader to mobilize and to involve these organizations in the design and the implementation processes of the program so that the promotion of the LAES contracts to farmers would be more efficient. We also show in this study that political circle like farm unions acts as a channel of information for the farmers. While the level of information and decision-making costs may be reduced when mobilizing such a network, it is the content of the information diffused within this channel that ultimately influences the farmer decision. This is why the farmers unions' channel of information may compete with and substitute to that of the project leader. But, as our model do not account of the nature of the information diffused in the analysis of the role of networks in the adoption decision, it will be pertinent to address this question in future research.

To conclude, our results suggest that beyond the positive or negative effect of farmers' professional or personal networks, the implication of a large variety of local organizations, such as agricultural structures, benefiting from farmers' confidence, in the LAES definition and implementation, improve the effectiveness of the LAES territorialized program. Yet, while this improvement relies on the reduction of the transaction costs incurred by farmers in their decision-making and contracting processes, establishing links with a large variety of local organizations and developing trustworthy relationships are not without costs for the project coordinator. Indeed, the coordination costs that will be incurred by the project leader in the governance of the policy from this perspective are likely to be high, in particular, in presence of actors likely to have divergent interests. Therefore, the effectiveness of a decentralized public policy depends not only on the minimization of the production costs of the policy implementation (contract remunerations), costs associated with over-compensation of some type of measures due to information asymmetry), but also on a balance between the level of private costs borne by farmers and that of the public coordination costs incurred in the implementation of the agri-environmental transaction. Trade-offs exist and have to be taken into account when tailoring, implementing and diffusing such decentralized agri-environnemental policies.

VII. References

Allaire, G., Cahuzac, E. and Simioni, M. (2009), 'Contractualisation et diffusion spatiale des mesures agro-environnementales herbagères'.

AND International (2008), 'Evaluation ex post du Plan de Développement Rural National- Mesures Agro-environmentales', *Rapport final*, Marché CNASEA n°22-07: 42.

Antolín, A.F., Stathopoulos, A. and Bierlaire, M. (2014), 'Exploratory analysis of endogeneity in discrete choice models'.

Bandiera, O. and Rasul, I. (2006), 'Social networks and technology adoption in northern mozambique', *The Economic Journal,* 116 (514): 869-902.

Barreiro-Hurlé, J., Espinosa-Goded, M. and Dupraz, P. (2010), 'Does intensity of change matter? Factors affecting adoption of agri-environmental schemes in Spain', *Journal of Environmental Planning and Management,* 53 (7): 891-905.

Beckmann, V., Eggers, J.R. and Mettepenningen, E. (2009), 'Deciding how to decide on agri-environmental schemes: the political economy of subsidiarity, decentralisation and participation in European Union', *Journal of Environmental Planning and Management,* 52 (5): 689-716.

Berry, S., Levinsohn, J. and Pakes, A. (1995), 'Automobile prices in market equilibrium', *Econometrica: Journal of the Econometric Society*: 841-90.

Berry, S., Linton, O.B. and Pakes, A. (2004), 'Limit theorems for estimating the parameters of differentiated product demand systems', *The Review of Economic Studies,* 71 (3): 613-54.

Bonnieux, F., Rainelli, P. and Vermersch, D. (1998), 'Estimating the supply of environmental benefits by agriculture: A French case study', *Environmental and Resource Economics,* 11: 135-53.

Brun, F. and Chabé-Ferret, S. (2014), 'Le rôle de l'orientation syndicale des Chambres d'agriculture dans la contractualisation des mesures agro-environnementales', *VertigO-la revue électronique en sciences de l'environnement,* (Hors-série 20).

Cardona, A. and Lamine, C. (2010), 'Mobilisation et animation territoriale autour des réductions d'intrants: stratégies d'intéressement des agriculteurs dans trois territoires franciliens', *Colloque SFER La Réduction des Pesticides: Enjeux, Modalités et Conséquences*; 11/12 mars; Lyon, France: 13.

Case, A. (1992), 'Neighborhood influence and technological change', *Regional Science and Urban Economics,* 22 (3): 491-508.

Conley, T. and Udry, C. (2001), 'Social learning through networks: The adoption of new agricultural technologies in Ghana', *American Journal of Agricultural Economics*: 668-73.

Darré, J.-P., Le Guen, R. and Lemery, B. (1989), 'Changement technique et structure professionnelle locale en agriculture', *Economie rurale,* 192 (1): 115-22.

De Weerdt, J. and Dercon, S. (2006), 'Risk-sharing networks and insurance against illness', *Journal of Development Economics,* 81 (2): 337-56.

Defrancesco, E., Gatto, P., Runge, F., et al. (2008), 'Factors Affecting Farmers' Participation in Agri-environmental Measures: A Northern Italian Perspective', *Journal of agricultural economics,* 59 (1): 114-31.

Del Corso, J.-P. and Képhaliacos, C. (2013), 'Améliorer la gouvernance territoriale de biens publics environnementaux au moyen d'institutions discursives', *Géographie, économie, société,* 14 (4): 393-409.

Drake, L., Bergström, P. and Svedsäter, H. (1999), 'Farmers' attitudes and uptake', *Countryside Stewardship: Farmers, Policies and Markets. Oxford: Elsevier Science Ltd*: 89-111.

Ducos, G. and Dupraz, P. (2006), 'Private provision of environmental services and transaction costs: Agroenvironmental contracts in France', *Contribution paper to the 3rd World Congress of Environmental and Resource Economists. 3rd - 7th July, Kyoto, Japan*, 24.

Ducos, G., Dupraz, P. and Bonnieux, F. (2009), 'Agri-environment contract adoption under fixed and variable compliance costs', *Journal of Environmental Planning and Management,* 52 (5): 669-87.

Dupraz, P., Latouche, K. and Turpin, N. (2007), 'Programmes agri-environnementaux en présence d'effets de seuil', *Cahiers d'Economie et Sociologie Rurales,* 82: 5-32.

Dupraz, P., Vermersch, D., De Frahan, B.H., et al. (2003), 'The environmental supply of farm households: a flexible willingness to accept model', *Environmental and resource economics,* 25 (2): 171-89.

Espinosa-Goded, M., Barreiro-Hurlé, J., and Dupraz, P. (2013). 'Identifying additional barriers in the adoption of agri-environmental schemes: The role of fixed costs'. *Land Use Policy*, 31, 526-535.

Falconer, K. (2000), 'Farm-level constraints on agri-environmental scheme participation: A transactional perspective', *Journal of Rural Studies,* 16 (3): 379-94.

Falconer, K. and Whitby, M. (1999), 'The invisible costs of scheme implementation and administration', *Countryside Stewardship: farmers, policies and markets*: 67-88.

Feder, G. and Slade, R. (1984), 'The Acquisition of Information and the Adoption of New Technology', *American Journal of Agricultural Economics,* 66 (3): 312-20.

Foster, A.D. and Rosenzweig, M.R. (1995), 'Learning by Doing and Learning from Others: Human Capital and Technical Change in Agriculture', *Journal of Political Economy,* 103 (6): 1176-209.

Gassiat, A. and Zahm, F. (2010), 'La territorialisation des MAE, entre territoires subis et territoires construits autour de l'enjeu eau', *2ème rencontre du Territoire*; 07/12/2010, Grenoble, France: 11.

Gassiat, A., Rousset, S. and Zahm, F. (2010), 'Improving water quality with a “territorial” agri-environmental policy? Insights from the new generation AES in South-West France', *50th Congress of the European Regional Science Association*; 19-23/08/2010, Jönköping, Sweden: 20.

Giovanopoulou, E., Nastis, S. A., and Papanagiotou, E. (2011). 'Modeling farmer participation in agri-environmental nitrate pollution reducing schemes'. *Ecological economics*, 70(11): 2175-80.

Guevara-Cue, C.A. (2010), 'Endogeneity and sampling of alternatives in spatial choice models', Thesis Ph. D. (Massachusetts Institute of Technology, Dept. of Civil and Environmental Engineering)

Guevara, C.A. and Ben-Akiva, M. (2010), 'Addressing endogeneity in discrete choice models: Assessing control-function and latent-variable methods', *Choice modelling: The state-of-the-art and the state-of-the-practice*: 353-70.

Gujarati, D.N. (1995), 'Basic Econometrics, McGraw-Hill', *Inc., New York*.

Heckman, J.J. (1979), 'Sample selection bias as a specification error', *Econometrica: Journal of the econometric society*: 153-61.

Kephaliacos, C. and Ridier, A. (2007), 'Mise en oeuvre de la conditionnalité des aides directes dans le cadre de la PAC 2003 : Approche par les coûts de production et de transaction', *ENFA & LEREPS-Université de Toulouse*.

Kuhfuss, L., Jacquet, F., Préget, R., et al. (2012), 'Le dispositif des MAEt pour l’enjeu eau : Une fausse bonne idée ?', *Revue d'Etudes en Agriculture et Environnement,* 93 (4): 395-422.

Lastra-Bravo, X.B., Hubbard, C., Garrod, G., et al. (2015), 'What drives farmers’ participation in EU agri-environmental schemes?: Results from a qualitative meta-analysis', *Environmental Science & Policy,* 54: 1-9.

LeSage, J.P. (2000), 'Bayesian estimation of limited dependent variable spatial autoregressive models', *Geographical Analysis,* 32 (1): 19-35.

LeSage, J.P. and Pace, R.K. (2009), *Introduction to spatial econometrics*, ed. CRC Press (Boca Raton): Taylor and Francis Group.

Louis, M. and Rousset, S. (2010), 'Coûts de transaction et adoption des contrats agroenvironnementaux : le cas des MAE Territorialisées à enjeu « eau » en Poitou-Charentes', *Colloque SFER "La réduction des pesticides agricoles, enjeux, modalités et conséquences",* Lyon, France.

Lubell, M. (2004), 'Collaborative Watershed Management: A View from the Grassroots', *The Policy Studies Journal,* 32 (3): 341-61.

Lubell, M. and Fulton, A. (2007), 'Local policy networks and agricultural watershed management', *Journal of Public Administration Research and Theory,* 18 (4): 673-96.

McFadden, D. (1974), 'Conditional logit analysis of qualitative choice behavior', in P. Zarembka (ed.), *Frontiers in Econometrics* (New York: Academic Press): 105-42.

Mettepenningen, E., Verspecht, A. and Van Huylenbroeck, G. (2009), 'Measuring private transaction costs of European agri-environmental schemes', *Journal of Environmental Planning and Management,* 52 (5): 649-67.

Ministère-de-l'agriculture (2007), 'Programme de développement rural hexagonal (PDRH) 2007-2013': 1064.

Manski, C.F. (2000), 'Economic analysis of social interactions', *National bureau of economic research,* No. w7580

Morrison, M.D., Durante, J., Greig, J., et al. (2008), Encouraging participation in market based instruments and incentive programs. Final report prepared for Land and Water Australia.

Munshi, K. (2004), 'Social learning in a heterogeneous population: technology diffusion in the Indian Green Revolution', *Journal of development Economics,* 73 (1): 185-213.

Nguyen, G., Corso, J.-P.D., Kephaliacos, C., et al. (2013), 'Pratiques agricoles pour la réduction des produits phytosanitaires. Le rôle de l'apprentissage collectif', *Économie rurale. Agricultures, alimentations, territoires,* (333): 105-21.

Peerlings, J. and Polman, N.B.P. (2009), 'Farm choice between agri-environmental contracts in the European Union', *Journal of Environmental Planning and Management,* 52 (5): 593-612.

Polman, N.B.P. and Slangen, L.H.G. (2008), 'Institutional design of agri-environmental contracts in the European Union: the role of trust and social capital', *NJAS-Wageningen Journal of Life Sciences,* 55 (4): 413-30.

Tobler, W.R. (1970), 'A computer movie simulating urban growth in the Detroit region', *Economic geography*: 234-40.

Train, K.E. (2009), *Discrete choice methods with simulation*: Cambridge university press.

Vanslembrouck, I., Van Huylenbroeck, G. and Verbeke, W. (2002), 'Determinants of the Willingness of Belgian Farmers to Participate in Agri-environmental Measures', *Journal of Agricultural Economics,* 53 (3): 489-511.

Wilson, G.A. (1997), 'Factors influencing farmer participation in the Environmentally Sensitive Areas Scheme', *Journal of Environemental Management,* 50(1): 67-93.

Wilson, G.A. and Hart, K. (2000), 'Financial imperative or conservation concern? EU farmers' motivations for participation in voluntary agri-environmental schemes', *Environment and planning A,* 32 (12): 2161-86.

Wynn, G., Crabtree, B. and Potts, J. (2001), 'Modelling farmer entry into the environmentally sensitive area schemes in Scotland', *Journal of agricultural economics,* 52 (1): 65-82.

VIII. Appendices

Appendix1 - Table 3. Descriptive statistics of the dependent and exploratory variables of the models

Variables		Description	Obs	Mean	Std. er.	Min	Max
$LAES_i$		Binary choice variable (=1 for LAES contract adoption ; 0 otherwise)	166	.69	.46	0	1
$LAESAcreage_i$		Measure of the LAES adoption intensity, defined within [0; S_E]	115	30.99	23.81	1.45	135.75
Independent variables							
X_i	NonEligArea	The surface of non-eligible area (in ha)	166	30.28	46.26	0.00	231.58
	Grassland	The surface of grassland (in ha), capturing the main land cover type (as LAES measures are proposed according to the land actual cover)	166	58.90	51.34	0	277.43
	Age	Medium age of the farm household	166	44.62	8.80	26	65
	AESexpe	Measures farmers' AES-attitude and farm management skills (=1 if the farmer have participated in previous AES contracts)	166	.62	.48	0	1
	OffActiv	Measure of the existence of off-farm income (= 1 if the farmer has off-farm employment; 0 otherwise)	166	.22	.42	0	1
	TerrFES TerrFEV TerrFEB	Variables capturing LAES project territory contextual effects (=1 for farms located within; 0 otherwise) Reference: TerrFEB	166	.48 .31 .19	.50 .46 .39	0 0 0	1 1 1
R_i	$Coop_i$	Captures the effect of the technical advisory network (= 1 if the farmer's cooperative is involved in the LAES implementation process ; 0 otherwise)	166	.43	.49	0	1
	PL_i	Measures the annual average frequency of interactions between the local project leader and farmers	166	1.75	1.15	0	4
	$FGroup_i$	Measures farmers' implication in farmer groups	166	.91	1.28	0	7
	$Union_i$	Measures farmers' personal involvement in farm union	166	.66	1.38	0	7
	$Neighb_i$	Measures the cumulative number of LAES adopters in a farm neighborhood (buffer zone =10km radius ; only farmers who have contracted in the previous campaign are considered)	166	18.04	15.72	0	47

Appendix 2 - Table 4. Two-stage and simultaneous estimation results for the PL_i orthogonality test

VARIABLES	(second stage) 2SCF $LAES_i$	(first stage) OLS PL_i	(joint estimation) IVPROBIT $LAES_i$ / PL_i
NonEligArea	-0.00481	1.09e-05	-0.00481
	(0.00361)	(0.00203)	(0.00407)
Grassland	**0.0108*** **	0.00145	**0.0108*** **
	(0.00347)	(0.00178)	(0.00416)
Age	**-0.0551*** **	0.00477	**-0.0548*** **
	(0.0178)	(0.00948)	(0.0199)
AESexpe	**0.724** **	0.0824	**0.722** **
	(0.318)	(0.177)	(0.314)
$Coop_i$	**1.092*** **	**0.363** **	**1.087*** **
	(0.363)	(0.163)	(0.362)
$Union_i$	**-0.191** **	**-0.107* **	**-0.191* **
	(0.0893)	(0.0611)	(0.116)
$Neighb_i$	**0.0256** **	0.00323	**0.0256* **
	(0.0113)	(0.00676)	(0.0146)
TerrFES	**2.041*** **	0.313	**2.029*** **
	(0.536)	(0.222)	(0.472)
TerrFEV	**1.748*** **	0.252	**1.736*** **
	2.041* **	0.313	**2.029*** **
PL_i	**0.340* **		0.336
	(0.289)		(0.319)
PL_i_res ($\hat{\mu}_i$)	-0.0538		
	(0.289)		
DumIrrig[12]		**0.731*** **	
		(0.184)	
DistCatch[13]		**-0.434*** **	
		(0.0767)	
Constant	-0.635	**1.676*** **	-0.338
	(1.087)	(0.538)	(1.095)
N	164	166	166
R-squared		0.272	
Wald test of exogeneity (p.value)			0.02 (0.8750)
Amemiya-Lee-Newey test of overidentifying restrictions			0.544 (0.4609)
Instrumented: PLlinks			
Instruments: NonEligArea Grassland Age AESexpe CoopInvolved FarmUnion Neighbors TerrFES TerrFEV DumIrrig DistCatch			

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

[12] Due to lack of data on the surface of irrigated land in the farm, **DumIrrig** = 1 if the farmer has a portion of irrigated land; 0 otherwise

[13] **DistCatch** is the Euclidian distance from the centroid of the farm to the nearest point of a water catchment or sensible stream. Data on water catchments and stream are from the IGN BDTopo® http://professionnels.ign.fr/sites/default/files/DC_BDTOPO_2-1.pdf. Calculation was made using the spatial analyst extension package of ArcGIS 10.

Appendix3 - Table 5. Estimation results of the LAES contract adoption and marginal effects.

	Probit	Probit accounting for strategic interaction	Probit model accounting for spatial autocorrelation	
	(1) Probit	(2) SAR[14]	(3) SEM[15]	Change in probability
VARIABLES	LAES	LAES	LAES	LAES
NonEligArea	-0.00385	0.00413	-0.00452	-0.11%
	(0.0024)	(0.00311)	(0.00364)	
Grassland	**0.00669****	0.00353	0.002691	0.271%
	(0.0028)	(0.00359)	(0.00368)	
Age	**-0.0470*****	**-0.06391*****	**-0.07232*****	**-1.28%*****
	(0.0140)	(0.01919)	(0.0234)	
AESexpe	**0.745*****	**0.75273****	**0. 78886****	**19.45%****
	(0.185)	(0.29043)	(0. 32853)	
$Coop_i$	**0.793*****	**0.81001****	**0. 84395*****	**23.64%*****
	(0.224)	(0.31901)	(0. 37117)	
PL_i	**0.292*****	**0.38086*****	**0. 44834*****	**8.31%*****
	(0.0934)	(0.129610)	(0. 15960)	
$Union_i$	**-0.184*****	**-0.18043***	**-0. 18449***	**-5.03%***
	(0.0532)	(0.09552)	(0. 10788)	
$Neighb_i$	**0.0210****		**0.02160****	**0.589%****
	(0.0098)		(0.0099)	
TerrFES	**1.670*****	**2.21375*****	**2. 43807*****	**53.35%*****
	(0.372)	(0.44574)	(0. 5990)	
TerrFEV	**1.417*****	**2.10353*****	**2. 18907*****	**33.20%*****
	(0.424)	(0.49933)	(0. 69712)	
Constant	-0.0962	-0.485	-0.45918	
	(0.615)	(0.883)	1.01294	
ρ		**0.55681****		
		(0.274815)		
λ			**1.2540*****	
			(0. 03372)	
N	166	166	166	
McFadden's R^2	0.563			
Log lik. (df=13)	-44.701	-47.09243	-48.2103	
AIC	111.402	116.1849	122.4206	

Standard errors in parentheses
Change in probability evaluated at sample means
*** p<0.01, ** p<0.05, * p<0.1

[14] The model (2) is a probit estimation accounting for spatial dependence in neighboring farms' decision. As the neighborhood variable $Neighb_i$ is a good proxy of farmers' spatial dependence ($\rho = -0.0184$ and is no longer significant when $Neighb_i$ is included in the SAR model (2). We retain the non-spatial model and control for spatial autocorrelation in the estimation of (3).

[15] Probit model with spatial autocorrelation correction, estimated with the Bayesian Markov Chain Monte Carlo (MCMC) developed in Lesage and Pace, (2009), using R statistical package.

Appendix4 - Table 6. Estimation results of the extent of LAES adoption and marginal effects

	(Result Eq.) Heckman $LAESAcreage_i$	(Selection Eq.) $LAES_i$	Change in probability
PctEligArea	**26.45***** (6.233)		**26.45%*****
NonEligArea	-	-0.00353 (0.00393)	-
Grassland	**0.190***** (0.0335)	**0.00798***** (0.00285)	**0.19%*****
Age	0.180 (0.139)	**-0.0426***** (0.00934)	0.180%
ExpeAES	**7.824*** (4.384)	-0.0228 (0.370)	**7.82%***
$Coop_i$	**9.052**** (3.802)	**0.701***** (0.239)	**9.05%****
PL_i	1.845 (1.654)	**0.237**** (0.118)	1.85%
$Union_i$	-0.950 (2.123)	-0.111 (0.104)	-0.95%
$Neighb_i$	0.0253 (0.156)	0.0141 (0.0117)	0.03%
TerFES	**19.38**** **(7.808)**	**1.772***** **(0.352)**	**19.38%****
TerFEV	**16.26**** **(7.747)**	**1.378***** **(0.372)**	**16.26%****
$FGroup_i$	**-3.306**** (1.300)		**-3.30%****
OffActiv[16]		**-0.596***** **(0.208)**	
Awareness		**0.546**** **(0.274)**	
Inv. Mills ratio	**21.25587***** (2.430425)		
athrho	**16.96***** (0.0962)		
lnsigma	**3.057***** (0.114)		
Constant	**-41.52***** (5.258)		
Observations	166	166	
Censored obs.	51		
Log-lik (df)	-535.7186 (14)		
AIC / BIC	1099.437 / 1143.005		
Wald test of ind. Eq. (rho=0)	31099.41***		

Robust standard deviations in parentheses ; *** p<0.01, ** p<0.05, * p<0.1

[16] Instruments : **Farmers' participation to off-farm activity** (OffActiv = 1 if the farmer has off-farm revenues; 0 otherwise) is assumed to affect the probability to adopt a LAES contract, not the magnitude of the adoption. **Farmers' awareness about the water quality degradation in the LAES territory** (= 1 if the farmer put "degradation of water quality" among the main principal problems in the territory; 0 otherwise) is also assumed to affect the farmer's propensity to contract a LAES measure, without influencing the intensity of land he/she will allocated in the contract.