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Abstract

Martinique, a French island and overseas department, faces many environmental challenges including a humid tropical climate prone to the development of pests, the decline of its agricultural sector and a deterioration of its environment. Despite these constraints, Martinique has to meet both national and European environmental requirements. In order to understand the main drivers of agroecological transition on the island, our study considers the role of both formal and informal networks in addition to individual and structural characteristics of farms. Based on a representative database of Martinican farms, our study highlights two main results. First, the individual characteristics of farmers influence their productive practices, while the structural characteristics of their farms have no impact. For farmer-owners, a farm has a value in terms of transmission translating into a desire to protect soil quality and hence to implement agroecological principles. Second, networks play an important role in the implementation of more environmentally-friendly practices. In Martinique, the main drivers are informal networks as Martinican farmers observe at the neighbourhood level both positive and negative impacts of the implementation of alternative practices.

Keywords: agroecological transition; formal and informal networks, Martinique

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1. Introduction

The agricultural intensification after the Second World War largely relied on synthetic pesticides. Nowadays, there is a general consensus concerning the negative effects of such products and all stakeholders, whether private or public, agree on the fact that pesticides should be reduced because of their impacts on the environment and human health. From a regulatory and legislative standpoint, a large array of rules, standards, certifications, labels and specifications already influence food systems. Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009 establishes a framework for Community action to achieve a sustainable use of pesticides. It states that : "*this Directive establishes a framework to achieve a sustainable use of pesticides by reducing the risks and impacts of pesticide use on human health and the environment and promoting the use of integrated pest management and of alternative approaches or techniques such as non-chemical alternatives to pesticides*" (European Parliament and the Council, 2009). Furthermore, in light of the increasing number of stringent norms and standards that regulate the international trade, we might expect the quantities of synthetic pesticides used for production and storage to be falling, but this is not the case in France.

In recent years, France has set up and developed a regulatory framework and incentives specifically aimed at reducing the use of synthetic pesticides by half. The Ecophyto I (2008), Ecophyto II (2015) and Ecophyto II+ (2018) plans were designed to reduce dependency on synthetic pesticides by focusing on the systemic approaches found in the field of agroecology. The French government defines agroecology as *"the application of ecological science to the study, design and management of sustainable agrosystems"*, and as a *"set of agricultural practices favouring biological interactions aiming at an optimal use of the possibilities offered by agrosystems"*[1]. The challenge is therefore to adopt a systemic approach involving all stakeholders to achieve an agroecological transition (FAO, 2014).

One of the reference indicators for these plans, in accordance with European standards, is the "quantity of active substances" sold each year in the country (*QSA: Quantité de Substances Actives*). Statistics from the French Government (2020) show that total QSA was 85,876 tons in 2018. Despite the implementation of the Ecophyto plans, the observed dynamics of the QSA

[1] This definition is published in the Official Journal of the French Republic of 19 August 2015, available at: https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000031053235

display an upward trend: +21% between 2017 and 2018, and +22% between 2009-2011 and 2016-2018 (three-year average) (French Government, 2020). A similar trend concerns pesticide sales in France between 2013 and 2016 according to the European Environment Agency[2].

We focus our analysis on the context of Martinique, an island and a French department in the Caribbean. Martinique is a relevant case study for several reasons. First, Martinique has to comply with national and European phytosanitary requirements. Second, Martinique has a humid tropical climate with no winter season during which the prevalence of bioagressors (pests, diseases, weeds) is dramatically reduced. The almost uninterrupted rains and the warm temperatures all year long favour constant pest attacks. This situation makes the fight against pests more difficult than in temperate countries. These two factors combined provide a glimpse of what awaits developing tropical countries in their quest for pesticide reduction.

Moreover, Martinique faces the challenges of a declining agricultural sector and environmental degradation. In 2019, the 2,700 farms covered 21% of the surface of the island, employing 4% of the wage-earning population and accounting for 3% of gross production (Direction de l'Alimentation de l'Agriculture et de la Forêt de la Martinique, 2019). From 1973 to 2019, the number of farms decreased from 16,900 to 2,700 while the area of farmland fell from 51,100 ha to 23,196 ha (Direction de l'Alimentation de l'Agriculture et de la Forêt de la Martinique, 2019, Saffache et al., 2005). Between 2010 and 2017, the area farmed decreased by 12% (Direction de l'Alimentation de l'Agriculture et de la Forêt de la Martinique, 2011). Beyond agricultural decline, Martinique is also facing environmental degradation. In 2018, for example, the persistent insecticide chlordecone received large media coverage (Vincent, 2018). Banned in 1993 in the French West Indies, this insecticide contaminated arable land, staple crops and the population. This contamination led to a significant increase in the risk of prostate cancer with an increased concentration of plasma chlordecone (Multigner et al., 2010, Woignier et al., 2012). Herbicides currently account for 80% of all synthetic pesticides (as active substances) sold in Martinique (Préfecture de Martinique, 2016).

Finally, like most small island economies, Martinique is largely dependent on imports with only a 9.8% export/import ratio (IEDOM, 2019). Mainly consisting of banana and sugar cane-rum production, the agricultural sector plays an important role in the social and territorial balance

[2] According to a note published on its official website: https://www.eea.europa.eu/airs/2018/environment-and-health/pesticides-sales

of the island. Vegetable production, for example, meets only 36% of local demand (Direction de l'Alimentation de l'Agriculture et de la Forêt de la Martinique, 2015).

For all these reasons, Martinique is a relevant case study to assess the agroecological transition necessary to reduce the use of pesticides. While large-scale banana and sugar cane plantations are engaged in environmentally-friendly practices (Direction de l'Alimentation de l'Agriculture et de la Forêt de la Martinique, 2013), less is known about all the smaller farms involved in vegetable production. In the second section, we present the theoretical hypotheses on which we base our study. In the third section, we present the database and the econometric model. In the fourth section, we discuss the results before concluding.

2. Theoretical framework

The literature underlines the relevance of several key drivers for the implementation of environmentally-friendly practices. More than being stimulated by national and European requirements, the implementation of these practices is facilitated upstream by improved agronomic and technical support, favoured by collective organization, whether formal or informal, and dependent on farmers' and farm characteristics.

2.1. Networks

Farmers can belong to social or private groups. Either formal (Zhou et al., 2011, Adsadpur, 2011, Pereira de Herrera and Sain, 1999, Traoré et al., 1998, McDonald and Glynn, 1994) or informal (Bultena and Hoiberg, 1983, Warriner and Moul, 1992, Saltiel et al., 1994, Bonabana-Wabbi, 2002, Sharma et al., 2015), these groups incite farmers to reduce the use of chemical inputs (Aubert, 2017). As a matter of fact, groups can act as learning forums (Arocena and Sutz, 2000) or innovation platforms (Hounkonnou et al., 2012). Considering producer organizations (POs) more specifically, their role – beyond concentrating production – is to train and support producers in changing their productive practices (Adsadpur, 2011, Pereira de Herrera and Sain, 1999). POs *"also assist producers in the management of their crops"* (Bonnaud, 2012). These structures train farmers by providing them with an up-to-date inventory of approved products and corresponding authorized doses. POs offer information about long-term environmental effects of pesticide use and alternative practices. Through technical experts who are members of POs, farmers also benefit from technical and agronomy advice (Aubert, 2017).

Hypothesis 1.1. Being a member of a PO increases the likelihood of implementing more environmentally-friendly practices

In addition to these POs, farmers can be members of an informal network. These networks are defined by the informal dimension of the relationship and not by the number of relationships. Regardless of the size of the network, the key point is the access of farmers to information regarding farming practices. The main type of network is the neighbourhood (Adsadpur, 2011, Pereira de Herrera and Sain, 1999, Fernandes et al., 2009). Informal discussions can help farmers to benefit from the experience and feedback of farmers involved in more environmentally-friendly practices. This can encourage non-adopters to change their productive practices by observing agronomic and economic implications among their neighbours who have adopted certain practices (Pereira de Herrera and Sain, 1999).

Hypothesis 1.2. Benefitting from an informal network increases the likelihood of implementing more environmentally-friendly practices

Institutions also play a key role in spreading information that helps farmers to change their productive practices in favour of more environmentally-friendly ones. In particular, the intervention of technicians from the Chamber of Agriculture allows farmers to benefit from agronomic and technical advice. In France, the Chambers of Agriculture were created at the beginning of the 20th century to promote agricultural interests vis-à-vis public authorities. In accordance with French Law no. 2014-1170 for the future of agriculture, their role is also to contribute to the development of agroecology. As underlined by the national court of auditors, a chamber of agriculture is a natural relay enabling the state to implement its agricultural development policy, now based on the triptych of economic, social and environmental performance. Technicians from the Chamber of Agriculture support producers, in particular by providing technical and agronomic advice to farmers. Hence, technicians play a leveraging role, inciting farmers to change their productive practices (McDonald and Glynn, 1994, Traoré et al., 1998).

Hypothesis 1.3. Information given by technicians from the Chamber of Agriculture plays a positive role in the implementation of more environmentally-friendly practices

2.2. Farmers' individual characteristics

The literature highlights farmers' education levels, and more precisely their agricultural education levels, as a key determinant of the implementation of more environmentally-friendly practices (Geniaux et al., 2010, Alabi, 2003, Barzman et al., 2011). The literature emphasizes that the agricultural education level is more relevant to understanding the implementation of more environmentally-friendly practices than the general education level (Morgan and Murdoch, 2000). As a matter of fact, to implement these practices, farmers must be able to identify the appearance and assess the spread of pests and diseases in order to take rapid action before the need for pesticide use. Besides their initial education level, farmers usually complement their agricultural education by means of vocational agricultural training. This additional training reflects a dynamic of continuous improvement of farming practices, particularly in favour of environmentally-friendly practices.

Hypothesis 2.1. Vocational agricultural training of farmers has a positive impact on the implementation of more environmentally-friendly practices

Beyond the farmers' education level, the literature underlines the relevance of considering several key individual indicators to understand the changes in productive practices. The first is the fact that a farmer declares themself to be in full-time employment. Farmers who work full time on their farm can spend more time on observation (Gould et al., 1989, Aubert et al., 2019). Hence, we assume that farmers who have no off-farm activity are more involved and that they are more likely to implement more environmentally-friendly practices.

Hypothesis 2.2. A farmer's involvement on his farm has a positive impact on the implementation of more environmentally-friendly practices

The involvement of farmers in terms of pesticide reduction depends on whether or not the farmer is the owner of the farm. The literature underlines the fact that farmers are much more eager to change their practices if they own their farm (Feder et al., 1985, Clay et al., 1998). It should be noted that investments in alternative practices cannot necessarily be re-deployed from one plot to another. This represents a potential brake on the implementation of more environmentally-friendly practices. As a matter of fact, in the event of non-renewal of the agricultural land use contract, a farmer loses his investment even if he can benefit from another contract on another plot.

Hypothesis 2.3. Being a farmer-owner has a positive impact on the implementation of more environmentally-friendly practices

2.3. Farm structure

Beyond farmers' individual characteristics, the literature identifies a range of other drivers relating to farm structural characteristics which lead to the reduction of pesticide use. The first element is the degree of diversification. Crop diversification is considered a decisive prevention strategy with a positive impact on environmentally-friendly practices (Barzman et al., 2015) and income (Ellis, 1998, Parrot et al., 2008). Mono-cropping systems are more dependent on synthetic pesticides than diversified systems (Malézieux, 2012). Farmers who operate mixed-cropping activities are therefore less dependent on synthetic pesticides.

Hypothesis 3.1. The degree of farm diversification has a positive impact on the implementation of more environmentally-friendly practices

The total cultivated area is universally underlined by the literature to be a key determinant of the implementation of more environmentally-friendly practices and almost all studies demonstrate its positive impact (Feder et al., 1985, Lefebvre et al., 2014). The cultivated area is synonymous with capital (Feder et al., 1985, Galt, 2008), economies of scale (Jaffee et al., 2005, Caswell et al., 2001), access to credit (Feder et al., 1985, Fernandez-Cornejo and Ferraioli, 1999) and financial resources (Knowler and Bradshaw, 2007). Farmers whose total area is higher are therefore more likely to implement more environmentally-friendly practices.

Hypothesis 3.2. The total cultivated area has a positive impact on the implementation of more environmentally-friendly practices

2.4. Control variables

Innovations are implemented in relation to biotic and abiotic environmental factors. Farm structure, and more precisely its agroecological environment characteristics, are important factors influencing the adoption of sustainable farming practices. Farmers who consider that the most worrying problems at the agronomic level relate to bioagressors will be more prone to protecting their production and hence to adopting alternative practices (Gould et al., 1989, Ervin and Ervin, 1982).

Hypothesis 4.1. Farmers who suffered from the pressure of bioagressors during the previous campaign are more likely to implement more environmentally-friendly practices

We control for the geographical location and more precisely the fact that the farm is located on sloping ground. Since these farms cannot use mechanization (Aynsau and De Graaff, 2007), they are less likely to use pesticides (Aubert et al., 2019).

Hypothesis 4.2. Farms located on sloping ground are more likely to implement more environmentally-friendly practices

Figure 1 summarizes the theoretical hypotheses considered in our study.

Figure 1. Synthesis of theoretical hypotheses

3. Empirical framework

This section describes the database and the econometric model.

3.1. Database

From the 2010 Martinique census database, which identifies all farms of the island, we selected farms specializing in vegetable productions. The census mainly collects information about farms and their owners. Because we needed more specific and precise information about farmers' interaction with formal and informal networks, we created an additional sample based on a stratified sampling. Criteria considered for the stratification are the location and the production implemented. We also considered whether a farmer is a member of a PO. The data collected are representative of vegetable farms in Martinique. Hence, among the 3,307 farms of the island, 1,382 produce vegetables and we surveyed 120 of these. Our study focuses on these farms.

In order to understand the extent to which farmers are more or less likely to implement more environmentally-friendly practices, we collected data relating not only to individual characteristics of the farmers, structural characteristics of their farms and the environment in which they operate, but also information relating to various networks, whether formal or informal (Table 1).

Table 1. List of variables and associated hypotheses

3.2. Statistical analysis and econometric modelling

Since the measure of such a reduction refers to several dimensions including quantities, active substances, treatments and monetary units, we decided to refer to the general concept of agroecology, which aims to combine competitive agricultural production with the sustainable use of natural resources. In our survey, we questioned farmers to find out if they had implemented alternative practices of any kind that allowed them to reduce their use of phytosanitary products. For the purpose of the analysis, we therefore differentiated farmers depending on whether they had innovated by implementing more environmentally-friendly practices. Because farmers' behaviour is considered to be dichotomic, we implemented a logit model.

The model can be formalized in a synthetic way, as follows:

$$MEFP_i = 1 \; if \; MEFP_i^* > 0; 0 \; otherwise$$

Farmer (i) decides to implement more environmentally-friendly practices (MEFP) conditional to a continuous effect that is not observed and denoted $MEFP_i^*$.

$$MEFP_i^* = \beta_0 + \beta_1 Network_i + \beta_2 Farmer_i + \beta_3 Farm_i + \beta_4 Control\ variables_i + \varepsilon$$

Where:

β_0 is the constant.

β_1 is a vector of coefficients associated with networks.

β_2 is a vector of coefficients associated with farmers' characteristics.

β_3 is a vector of coefficients associated with farm structure.

β_4 is a vector of coefficients associated with control variables.

ε is the error term

4. Results

We measured the implementation of more environmentally-friendly practices according to whether or not farmers declared that they implemented practices leading to a reduction in pesticide use. Not all farmers implemented the same practices but they shared the same environmental goals. Among the farmers surveyed, 67.5% had never implemented alternative practices to pesticide use.

4.1. Descriptive statistics

4.1.1. Networks

Statistical results underline that being a member of a network differs significantly according to the productive practices implemented (Table 2a and Table 2b).

Table 2a. Qualitative characterization of farmers and their farm according to their environmentally-friendly practices

Table 2b. Quantitative characterization of farmers and their farm according to their environmentally-friendly practices

Whatever the network considered, statistical results highlight the fact that farmers who are members of one of the identified networks are over-represented among innovative farmers. Respectively 50%, 78% and 28% of innovative farmers are members of a PO, an informal network or enjoy a relationship with a technician from the Chamber of Agriculture, while the figures are 25%, 30% and 13% respectively among non-innovative farmers. Farmers benefiting from information and advice, regardless of their source, seem to be more prone to changing their productive practices.

4.1.2. Farmers' characteristics

Farmers who implement more environmentally-friendly practices are more likely to own all or part of their farms. Property rights seem to act as a lever for the implementation of these practices. Three-quarters of farmers implementing more environmentally-friendly practices own their farm, while only 51.28% of non-owners do the same. Farmer-owners are more sensitive to the long-term quality of their soil and hence more concerned with land quality.

The results highlight a significant difference between innovative farmers and other farmers in terms of time spent on the farm. Farmers who implement alternative practices tend to be those who are more involved on their farm. More than 90% of innovative farmers are full-time farmers. These farmers are also over-represented among farmers who completed a vocational agricultural training. While 44.4% of innovative farmers completed such a training, the figures fall to 28.21% for non-innovative farmers.

4.1.3.Farm structure

Beyond farmer's individual characteristics that seem to differentiate farmers according to their productive practices, statistical results also underline the role of farm structural characteristics. Farms owned by innovative farmers are larger covering, on average, around 6 hectares while their size is smaller for other farmers, at less than 4 hectares. We also observe that innovative farms are no more diversified than other farms. With an average of 5.5 different types of crop grown on their farm, farmers who are willing to implement more environmentally-friendly practices are no more diversified than others.

4.1.4.Control variables

Concerning control variables, the statistical results highlight the fact that farmers who declare that pests are the most worrying agronomic problem is the only significant variable. While 55% of innovative farmers make such a statement, the figure falls to 47% in the case of non-innovative farmers. We observe that neither the fact that diseases are the most worrying agronomic problem nor the slope of the farm seem to affect productive practices implemented by farmers in Martinique.

4.2. Econometric results

The concordance rate, which serves to assess the performance of the prediction, is 85% (Table 3), which represents the validity of our model.

Table 3. Econometric model

4.2.1.Networks

Concerning the fact that a farmer is a member of a group, our results underline the fact that, in Martinique, informal networks play a key role. Farmers who are involved in an informal network have a much higher probability (24 times more likely) of implementing more environmentally-friendly practices than other farmers (*H 1.2 validated)*. In this context, an informal network is a relevant driver of a change in productive practices. Such a network, defined in terms of neighbourhood exchanges, provides tangible information on both the positive and negative impacts of such changes, which explains why farmers concerned are much more likely to implement more environmentally-friendly practices. Our study also underlines the key role of chambers of agriculture, as farmers benefiting from technicians' advice are 11 times more likely to implement alternative practices than others *(H 1.3 validated)*. This result underlines the particularity of this insular context. Finally, there is no relationship between being member of a PO and implementing more environmentally-friendly practices *(H 1.1 non-validated)*. This structure appears to support farmers at the marketing level more than at the production one.

Since these formal and informal networks are not exclusive, the originality of our approach is to consider the impact of being a member of several networks. Interaction terms specify the contribution of each network, but also their complementarities. More than considering the impact of these networks on the implementation of more environmentally-friendly practices in an independent way, our study therefore demonstrates the importance of combining access to informal information with information from formal networks. While being member of a PO has no impact on the practices implemented by farmers, we demonstrate that farmers who are members of both a PO and of an informal network are much more likely to adopt these practices than farmers who are only part of an informal network. The combination of formal and informal networks thus translates into a higher probability of implementing agroecological practices. In Martinique, informal networks play a more significant role in farmers' behaviour rather than in a continental context. We highlight the fact that this role is much more relevant when it is combined with the formal one.

Figure 2 sums up the relative impact of each network on the probability of implementing more environmentally-friendly practices.

Figure 2. Impact of networks on the implementation of more environmentally-friendly practices

4.2.2. Farmers' characteristics

The first result is that farmers who have benefitted from a vocational agricultural training are more likely to implement more environmentally-friendly practices. Farmers with such training are 3 times more likely to implement more environmentally-friendly practices *(H 2.1 validated)*. This training provides farmers with the keys to change their productive practices. Our study also demonstrates that farmers who own their farm are 8 times more likely to implement more environmentally-friendly practices than others *(H 2.3 validated)*. Almost all individual characteristics of farmers appear to be relevant to understanding pesticide reduction. However, our results emphasize that in the case of Martinique, the fact that a farmer works full time has no impact on his productive practices *(H 2.2 non-validated)*. This result can be explained by the fact that, in Martinique, the time spent by a farmer on his farm is not a brake to the implementation of more environmentally-friendly practices.

4.2.3. Farm structure

Our results highlight the fact that no structural farm characteristics affect the productive practices implemented by farmers. Neither the number of crops cultivated *(H 3.1 non-validated)* nor the total area cultivated *(H 3.2 non-validated)* has an impact on the implementation of more environmentally-friendly practices. These results emphasize the fact that the non-structural characteristics of farms are not an asset to or a break on agroecological transition in Martinique.

4.2.4. Control variables

Our results show that farmers who declare that pests are the most worrying problem at the agronomic level are more likely to implement more environmentally-friendly practices while there is no relationship with diseases *(H 4.1 partially validated)*. Farmers who declare that pests are the most worrying agronomic problem are 4 times more likely to implement alternative practices. As a matter of fact, these practices are a barrier to pests without having any effect on the appearance or dissemination of disease.

Our results also demonstrate that there is no relationship between the location of farms and the productive practices implemented by farmers *(H 4.2 non-validated)*. This highlights the fact that regardless of slope of the land on the farm, the implementation of more environmentally-friendly practices is technically possible. This geographical characteristic is not a brake on agroecological transition.

5. Conclusion

Martinique is a French island and overseas department facing several environmental challenges. Martinique is required to comply with national and European phytosanitary requirements while farmers operate in a humid Caribbean context, that translates into increased difficulty in fighting bioagressors than in temperate countries. At the same time, the agricultural sector is being restructured with the disappearance of small farms and the growth of those that remain. This case study is therefore relevant to understanding the agroecological transition designed to reduce the use of pesticides. The aim of our study is to assess the extent to which farmers are encouraged to implement more environmentally-friendly practices against such a backdrop.

The literature underlines the key role of both farmers' individual characteristics and farm structure. The originality of our study is first and foremost that it highlights these drivers in an insular context and second, that it extends this reflection by considering the impact of networks on productive practices implemented by farmers. Whether formal or informal, we measure the role of these networks and assess the impact of their interactions on farmers' behaviour. To this end, we created a database founded on stratified sampling using the exhaustive census of Martinique's farms in 2010. We collected representative information about farmers, their farms and their networks. The data allow us to determine the key drivers underpinning the implementation of more environmentally-friendly practices.

Two main results are highlighted. First, the individual characteristics of the farmer condition his productive practices, while structural farm characteristics have no impact on it. In Martinique, the implementation of more environmentally-friendly practices is conditioned by the fact that a farmer owns his farm. Farmer-owners have a long-term view of their land, and thus a greater interest in protecting their productive natural resources in the long term. This point explains why the characteristics of the farm have no impact on productive practices implemented by farmers. More than being farmer-owner, a key individual driver of the productive practices is the fact that a farmer has completed a vocational agricultural training. This point reinforces the fact that farmers need to be accompanied in the agroecological transition process and that training is a relevant way to do so.

Second, informal networks play a key role in the implementation of more environmentally-friendly practices. Our study shows that a combination of informal and formal networks contributes significantly to changing farmers' practices. Beyond benefiting from advice from technicians of the Chamber of Agriculture, who are key drivers of the implementation of alternative practices, we demonstrate the relevance of considering knowledge provided by informal networks. In Martinique, farmers appear to be very sensitive to their neighbours' experience. Observation of the positive as well as negative impacts of implementing more environmentally-friendly practices on closed plots is a main lever in encouraging farmers to change their productive practices.

The implementation of agroecological principles in Martinique will necessarily require the dissemination of information through both formal and informal networks. The combination of all these networks is a relevant lever for agroecological transition. It would be interesting to extend this research by analysing the whole food supply chain, and more precisely the marketing opportunities for more environmentally-friendly products.

Table 1. List of variables and associated hypotheses

Variable	Unit	Hypothesis	Expected influence on MEFP	Definition
				Agroecology
MEFP	Yes / No			1 if the farmer has ever adopted more environmentally-friendly practices; 0 otherwise
				Networks
PO	Yes / No	H1.1	+	1 if the farmer is a member of a producer organization; 0 otherwise
Informal	Yes / No	H1.2	+	1 if the farmer accesses informal information thanks to other farmers; 0 otherwise
Chamber	Yes / No	H1.3	+	1 if the farmer accesses information from technicians of the Chamber of Agriculture; 0 otherwise
				Farmer's characteristics
Agri-training	Yes / No	H2.1	+	1 if the farmer has completed a vocational agricultural training; 0 otherwise
Activity	Yes / No	H2.2	+	1 if the farmer is a full-time farmer; 0 otherwise
Owner	Yes / No	H2.3	+	1 if the farmer owns all or part of the farm; 0 otherwise
				Farm structure
Crops	Number	H3.1	+	Number of cultivated crops
Area	Hectare	H3.2	+	Total area of the farm
				Control variables
Diseases	Yes / No	H4.1	+	1 if the farmer indicates that diseases are the most worrying problem at the agronomic level; 0 otherwise
Pests	Yes / No	H4.2	+	1 if the farmer indicates that pests are the most worrying problem at the agronomic level; 0 otherwise
Slope	Yes / No	H4.3	+	1 if the farm is located on sloping ground; 0 otherwise

Table 2a. Qualitative characterization of farmers and their farm depending on whether or not they have ever adopted environmentally-friendly practices

		The farmer has adopted more environmentally-friendly practices			
		No	**Yes**	**Total**	**Chi2 test**
Farmers' characteristics					
Owner	No	48.72%	25.93%	33.33%	***
	Yes	51.28%	74.07%	66.67%	
Activity	No	23.08%	9.88%	14.17%	**
	Yes	76.92%	90.12%	85.83%	
Agri-training	No	71.79%	55.56%	60.83%	*
	Yes	28.21%	44.44%	39.17%	
Networks					
PO	No	74.36%	50.62%	58.33%	***
	Yes	25.64%	49.38%	41.67%	
Informal	No	69.23%	22.22%	37.50%	***
	Yes	30.77%	77.78%	62.50%	
Chamber	No	87.18%	71.60%	76.67%	*
	Yes	12.82%	28.40%	23.33%	
Control variables					
Diseases	No	76.92%	67.90%	70.83%	ns
	Yes	23.08%	32.10%	29.17%	
Pests	No	66.67%	46.91%	53.33%	**
	Yes	33.33%	53.09%	46.67%	
Slope	No	66.67%	77.78%	74.17%	ns
	Yes	33.33%	22.22%	25.83%	

Key: The null hypothesis considers equality of means or independence between the two populations. Means are significantly different at the 10% (*), 5% (**) and 1% (***) thresholds. The two populations are independent at the 10% (*), 5% (**) and 1% (***) thresholds.

Table 2b. Quantitative characterization of farmers and their farm depending on whether or not they have ever adopted environmentally-friendly practices

	The farmer has adopted more environmentally-friendly practices					
	No		**Yes**		**Equality of means / Std. Dev.**	
	Mean	**Std. Dev**	**Mean**	**Std. Dev**	**Mean**	**Std. Dev.**
Crops	5.5128	2.0374	5.4074	3.0157	ns	***
Area	3.8202	4.3821	5.6637	5.0455	*	ns

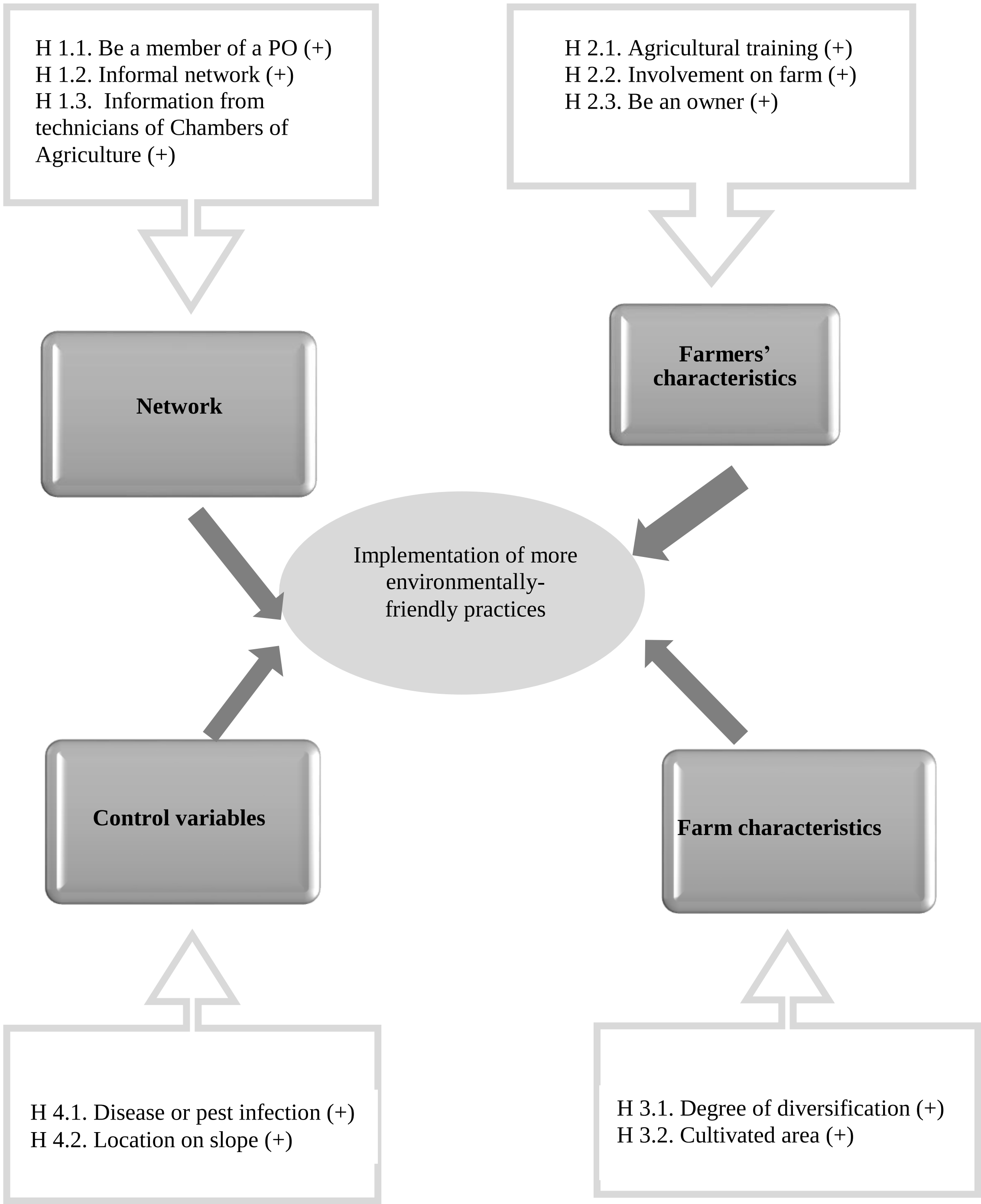
Key: The null hypothesis considers equality of means between the two populations. Means are significantly different at the 10% (*), 5% (**) and 1% (***) thresholds.

Table 3. Econometric model

	Coefficient	Odds Ratio	Std. Dev.	P>|z|
Farmers' characteristics				
Owner	2.302***	9.995***	7.977	0.004
Activity	0.464	1.589	1.291	0.568
Agri-training	1.215*	3.371*	2.326	
Farm structure				
Crops	0.045	1.046		
Area	0.056	1.058	0.084	
Networks				
PO	-2.029	0.131	0.157	
Informal	3.176***	23.955***	20.947	0.000
Chamber	2.402*	11.045*	13.695	0.053
Informal * Chamber	-3.376**	0.034**	0.058	0.047
Informal * PO	2.937*	18.863*	29.819	0.063
PO * Chamber	2.633	13.917	25.452	0.150
Control variables				
Diseases	1.534*	4.635*	3.661	0.052
Pests	2.006***	7.436***	5.792	0.010
Slope	-0.203	0.816		
Constant	-5.104	0.006***	0.008	0.000
Concordance rate		85%		

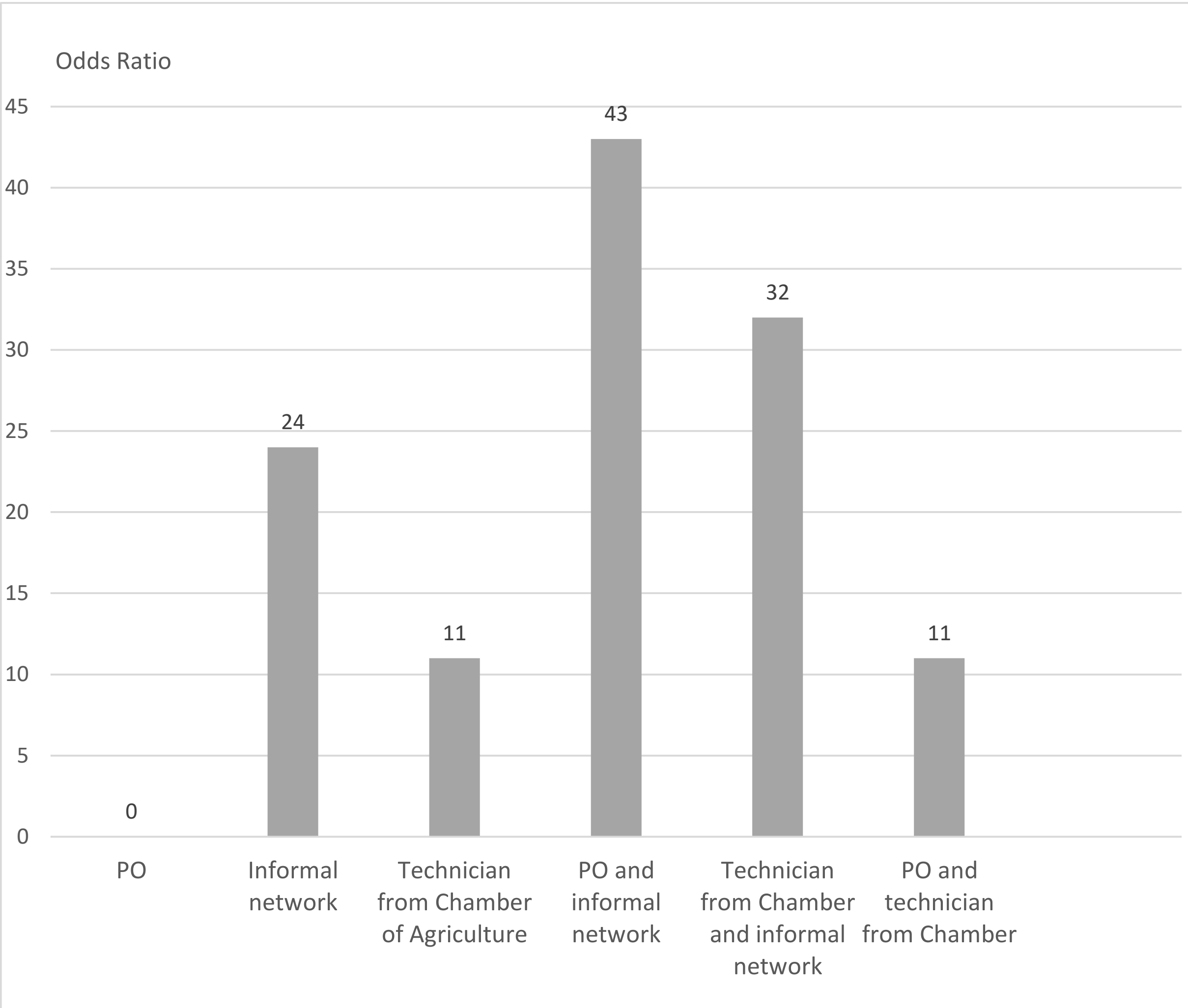
Key: Estimates are significant at the 10% (*), 5% (**) and 1% (***) thresholds.

Figure 1. Articulation between framework and theoretical hypotheses



Source: Own work, adapted from Vanslembrouck et al. (2002).

Figure 2. Impact of networks on the implementation of more environmentally-friendly practices



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