



**HAL**  
open science

## Contrats agro-environnementaux : approches comportementales et dispositifs innovants

Philippe Le Coent

► **To cite this version:**

Philippe Le Coent. Contrats agro-environnementaux : approches comportementales et dispositifs innovants. Economics and Finance. Université Montpellier, 2016. English. NNT : 2016MONTD006 . tel-01531507

**HAL Id: tel-01531507**

**<https://theses.hal.science/tel-01531507>**

Submitted on 1 Jun 2017

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# THÈSE

Pour obtenir le grade de  
Docteur

Délivré par l'**Université de Montpellier**

Préparée au sein de l'Ecole Doctorale d'Economie et de  
Gestion de Montpellier (EDEG)  
Et de l'unité de recherche : Laboratoire Montpelliérain  
d'Economie Théorique et Appliquée (LAMETA)

Spécialité : **Sciences Economiques**

Présentée par **Philippe LE COËNT**

**AGRI-ENVIRONMENTAL SCHEMES:  
BEHAVIORAL INSIGHTS AND INNOVATIVE  
DESIGNS**

**CONTRATS AGRO-ENVIRONNEMENTAUX :  
APPROCHES COMPORTEMENTALES ET  
DISPOSITIFS INNOVANTS**

**Sous la direction de :**

Sophie THOYER, Professeure, Montpellier SupAgro  
Raphaële PREGET, Chargée de Recherche, INRA

Soutenue le 17 Octobre 2016 devant le jury composé de :

Stefanie ENGEL, Professeure, Université d'Osnabrück

Anne ROZAN, Professeure, ENGEES

François DESSART, Analyste en politique, JRC- EU

Katrin PRAGER, Chargée de Recherche, James Hutton Institute

Sophie THOYER, Professeure, Montpellier SupAgro

Raphaële PREGET, Chargée de Recherche, INRA

Rapporteur

Rapporteur

Examineur

Examineur

Directrice de thèse

Co-directrice de  
thèse

**Présidente du Jury :**

**Anne Rozan**



« La faculté n'entend donner aucune approbation ni improbation aux opinions émises dans cette thèse ; ces opinions doivent être considérées comme propres à leur auteur »

**Summary:** The agri-environmental policy of the European Union strongly relies on financial incentives provided through Agri-environmental Schemes (AES) to stimulate farmers' adoption of pro-environmental practices. A rational economic assumption is that farmers enroll if they are paid enough to cover their opportunity costs. However, behavioral economics consider that psychologic factors may be involved in this decision. The first aim of this thesis is to determine the role of behavioral factors in AES adoption. Chapter 1 uses a social-psychology model, the Theory of Planned Behavior, to measure the weight of behavioral factors in farmers' decision to enroll in a pesticide-reduction AES. The survey reveals that farmers are both driven by traditional economic motivations and norms (social and personal). Chapter 2 studies in more details the role of norms. A theoretical model reveals that social norms may either hamper or facilitate the participation in AES and a web-survey, confirms the importance of social injunctive norms and personal norms. In the second part of the thesis, we analyze the performance of innovative designs and how it may be affected by behavioral factors. In chapter 3, to address cases of environmental threshold, we test with an economic experiment a contract in which payment is conditioned to collective farmers' participation. This contract appears to be more effective and efficient than traditional AES. The two last chapters analyze a new application of AES: biodiversity offsets. Based on a survey, chapter 4 highlights factors that influence the participation in such contracts as well as issues of effectiveness and efficiency. In chapter 5, we show with a choice experiment that farmers, especially the most environmentally sensitive, are influenced by the contracts' goal framing: they prefer contracts that aim at biodiversity conservation rather than at the compensation of biodiversity losses. We conclude by insisting on the complementarity between traditional and behavioral environmental policy instruments.

**Key words:** Agri-environmental schemes, Behavioral economics, Social norms, Theory of Planned Behavior, Experimental economics, Choice modelling.

---

#### CONTRATS AGRO-ENVIRONNEMENTAUX :

##### APPROCHES COMPORTEMENTALES ET DISPOSITIFS INNOVANTS.

**Résumé :** La politique agro-environnementale de l'Union Européenne s'appuie fortement sur des incitations financières, les Contrats Agro-Environnementaux (CAE), pour stimuler l'adoption par les agriculteurs de pratiques respectueuses de l'environnement. Selon l'hypothèse de rationalité économique, les agriculteurs adoptent ces contrats si les paiements couvrent leurs coûts d'opportunité. Toutefois, l'Economie comportementale considère que des facteurs psychologiques pourraient intervenir dans cette décision. Le premier objectif de cette thèse est de déterminer le rôle des facteurs comportementaux dans l'adoption des CAE. Dans le chapitre 1, nous utilisons un modèle de psychologie sociale, la Théorie du Comportement Planifié, pour mesurer le poids de ces facteurs dans la décision d'adopter un CAE pour la réduction de l'utilisation de pesticides. L'enquête révèle que les agriculteurs sont à la fois influencés par des motivations économiques classiques et par les normes (sociales et personnelles). Dans le chapitre 2, nous étudions plus en détails le rôle des normes. A travers un modèle théorique, nous mettons en évidence que ces normes peuvent faciliter ou faire obstacle à l'adoption de CAE. Une enquête web nous permet de confirmer l'importance des normes sociales injonctives et des normes personnelles. Dans la deuxième partie de la thèse, nous analysons les performances de dispositifs innovants et comment ces performances sont influencées par les facteurs comportementaux. Dans le chapitre 3, pour traiter le problème des seuils environnementaux, nous testons avec une expérimentation économique un contrat dont le paiement est conditionné à une participation collective des agriculteurs. Ce contrat se révèle plus efficace et efficient que les CAE classiques. Les deux derniers chapitres traitent d'une nouvelle application des CAE à la compensation écologique. A partir d'une enquête, nous identifions dans le chapitre 4 les facteurs qui influencent la participation à ce type de contrats ainsi que des problèmes d'efficacité et d'efficience. Dans le chapitre 5, nous montrons à partir d'une expérience de choix, que les agriculteurs, notamment les plus sensibles à l'environnement, sont sensibles à la manière dont est formulé l'objectif d'un CAE : ils préfèrent des contrats dont l'objectif est la préservation de la biodiversité, plutôt que la compensation de pertes de biodiversité. Nous concluons en insistant sur la complémentarité entre les instruments traditionnels et comportementaux dans la politique environnementale.

**Mots clés:** Contrats Agro-environnementaux, Economie Comportementale, Normes sociales, Théorie du Comportement Planifié, Economie expérimentale, Expérience de choix.

---

**Discipline :** Sciences Economiques

**Laboratoire d'accueil :** LAMETA – Laboratoire Montpellierain d'Economie Théorique et Appliquée – 2, place Pierre Viala – bat.26 – 34060 MONTPELLIER Cedex 02

---



## REMERCIEMENTS

Bon ben voilà. La thèse est écrite... enfin ! Ce moment des remerciements est toujours l'occasion d'un petit examen intérieur et rétrospectif sur les différentes étapes de ce long voyage que constitue la thèse.

D'abord et avant tout, comme dans tout voyage, les guides sont les premiers que je veux remercier : Sophie et Raphaële. Vous avez été disponibles pour m'aider à prendre les décisions importantes aux différents moments clés. Ce sont en grande partie les échanges que nous avons eus qui ont permis de mener à bien cette thèse. Vous avez également fait plus que guidé mais également directement contribué à une grande partie des travaux. Vous avez aussi su me laisser prendre des détours et réaliser certaines recherches avec plus d'indépendance. Tout ceci dans une ambiance sympathique et ouverte au dialogue ! Je souhaite à tout étudiant en thèse de bénéficier de guides de cette qualité.

Je voudrais ensuite mentionner les rencontres qui ont émaillées ce parcours et qui ont permis que ce travail puisse être mené à bien.

Robert Martin m'a donné accès au territoire de la coopérative Dom Brial avec une grande ouverture d'esprit et m'a permis de conduire la première enquête de cette thèse auprès des vignerons.

Les animateurs d'Aire d'Alimentation de Captage ainsi que leur animateur au carré, Johan Coulomb, ont également été ouverts pour participer à mon travail sur le rôle des normes sociales en se faisant notamment le relais auprès des agriculteurs. Tout ceci malgré leurs calendriers chargés et les nombreuses sollicitations dont ils font l'objet.

Je voudrais également remercier les membres du LEEM pour leurs idées et, en particulier, Dimitri Dubois pour son appui fiable et sympathique dans la réalisation d'expérimentations au laboratoire de l'Université de Montpellier.

Je suis également reconnaissant envers les membres des institutions impliquées dans la mise en place de la compensation écologique du projet CNM qui nous ont également donné accès au terrain et appuyés par leurs conseils dans la réalisation des travaux sur la compensation écologique : Grégoire Goettelmann d'Oc'Via, Gaëlle Boismery de la Chambre d'Agriculture

du Gard, Luis de Susa et Anne Pariente de la DREAL, Lionel Pirsoul du CEN-LR, Daniel Bizet du COGARD, Hortense Lebeau de Biositiv et enfin Thomas Menut et Fabien Quétier de Biotope.

Merci également à Coralie avec qui nous nous sommes bien battus pour réaliser l'enquête sur la compensation écologique. Les 1169 questionnaires à mettre en enveloppe n'ont pas été une mince affaire ! A travers nos échanges, tu m'as aussi donné la vision d'une approche différente de la recherche.

Laurent Garnier notre super bibliothécaire rockeur, toujours disponible pour aider à rechercher les articles introuvables et à dénicher les nouveautés, a été également d'une grande aide.

Je suis également reconnaissant envers les membres de mon comité de thèse pour leurs conseils avisés : Douadia Bougherara, Stefanie Engel et Xavier Poux.

Je souhaite également remercier les membres du LAMETA pour les échanges fructueux lors des séminaires PERENE mais également au cours de discussions informelles dans les couloirs.

Enfin et surtout, je voudrais remercier les agriculteurs qui ont bien voulu prendre un peu de leur précieux temps pour répondre à mes questions étranges et iconoclastes.

Tout voyage nécessite également une bonne animation. De ce point de vue, les volontaires pour des pauses café et de multiples apéritifs n'ont jamais manqué: Maxime, Laura, Coralie, Margot, Aziz, Guillaume, Laure, Mamadou, Anaïs, Lolo... Grâce à eux ces trois ans sont passés bien vite !

Finalement et évidemment, ce chemin a été parcouru à plusieurs. Merci Amélie d'avoir porté une partie des sacs notamment dans les étapes de montagne et sans jamais fléchir. Merci aussi à mes deux pétillantes petites filles, Elsa et Lucie, qui m'ont permis grâce à leurs sourires d'oublier instantanément régressions et consorts à la porte de la maison.

## TABLE OF CONTENT

<b>GENERAL INTRODUCTION</b> .....	<b>21</b>
1 AES history and main issues .....	23
1.1 AES brief history .....	23
1.2 Issues of AES.....	24
1.2.1 The participation issue .....	24
1.2.2 Issues stemming from information asymmetry .....	26
1.2.3 Issues of farmers' coordination at a landscape scale.....	28
2 Behavioral approaches of pro-environmental decisions .....	29
2.1 Behavioral economics.....	29
2.2 Pro-environmental behavior in social psychology .....	31
2.2.1 Moral motivation theories .....	31
2.2.2 The Theory of Planned Behavior (TPB) .....	32
2.3 The growing role of behavioral approaches in environmental policies.....	33
3 Research questions, hypotheses and methods .....	35
3.1 What is the role of behavioral factors in the adoption of AES? .....	35
3.1.1 Research question 1: Do behavioral factors intervene in the adoption of AES? .....	35
3.1.2 Research question 2: Do norms influence the adoption of AES? .....	37
3.2 What is the performance of innovative AES design and how it is affected by behavioral factors? .....	38
3.2.1 Research question 3: Does the introduction of a conditionality on collective participation improve the effectiveness and efficiency of AES contracts in presence of an environmental threshold? .....	38
3.2.2 Research question 4: Are AES performant to achieve the objectives of biodiversity offsets? .....	39
3.2.3 Research question 5: Does contract framing have an impact on the participation to AES? .....	41
<b>PART I: WHAT IS THE ROLE OF BEHAVIORAL FACTORS IN THE ADOPTION OF AES?</b> .....	<b>43</b>
<b>Chapter 1: Motivations of farmers to adopt AES: An application of the theory of planned behavior</b> .....	<b>45</b>

Introduction .....	45
1 The Theory of Planned Behavior .....	46
1.1 The initial TPB model .....	46
1.1.1 Attitude.....	47
1.1.2 Perceived Behavior Control .....	48
1.1.3 Subjective norm.....	48
1.1.4 Relative importance of TPB variables.....	49
1.2 Extensions of the TPB model .....	50
1.2.1 Descriptive norm .....	50
1.2.2 Personal norm.....	50
1.2.3 Response efficacy.....	50
1.2.4 Habits .....	51
1.3 Theory of planned behavior and economic theory .....	52
1.4 TPB applied to agri-environmental issues.....	53
2 Methodology of the empirical study .....	55
2.1 The case study .....	55
2.2 Sampling, survey design and administration .....	56
2.3 Questionnaire.....	57
2.4 Beliefs.....	59
2.5 Statistical analysis.....	60
3 Results and discussion.....	62
3.1 Analysis of directly measured TPB variables.....	62
3.2 Belief analysis.....	68
3.2.1 Attitude.....	68
3.2.2 Perceived behavior control.....	70
3.2.3 Subjective norm.....	72
4 Conclusion and discussion .....	74
<b>Chapter 2: Do social norms influence the adoption of AES?</b> .....	<b>77</b>
Introduction .....	77
1 What are social norms? .....	79
1.1 Definitions of social norms.....	79
1.2 Reasons to conform to social norms.....	80

1.3	Descriptive and injunctive norms .....	81
1.4	Importance of subjective beliefs .....	82
1.5	Social identity .....	83
1.6	Personal norms .....	83
2	Theoretical approaches of the role of social norms.....	84
2.1	Social norms in social psychology .....	84
2.2	Norms in economic models .....	85
2.3	Modelling the effect of descriptive and injunctive norms on the adoption of AES: our proposal .....	89
2.3.1	Basic framework .....	89
2.3.2	Descriptive norm .....	90
2.3.3	Injunctive norm .....	93
2.3.4	Combination of descriptive and injunctive norms .....	96
3	Empirical analysis of the effect of social norms on AES adoption.....	98
3.1	How to measure the effect of social norms on the adoption of AES?.....	98
3.1.1	Stated and revealed preference methodologies .....	98
3.1.2	Experimental methodologies.....	101
3.2	Empirical evidence of the role of social norms on pro-environmental behavior in agriculture.....	102
3.3	A stated-preference survey on the role of social norms in the adoption of pro-environmental practices.....	103
3.3.1	Survey methodology .....	104
3.3.2	Data analysis .....	108
3.3.3	Results and discussion.....	109
4	Conclusion and policy recommendations .....	115

**PART II: WHAT IS THE PERFORMANCE OF INNOVATIVE AES DESIGNS AND HOW IT IS AFFECTED BY BEHAVIORAL FACTORS?.....119**

**Chapter 3: Can collective conditionality improve AES? Insights from experimental economics.....121**

Introduction .....	121
1 Agri-environmental contracts with collective conditionality.....	123
2 Experimental design and procedure .....	125
2.1 Treatments .....	125

2.2	Discussion of the design and theoretical predictions.....	128
2.3	Protocol.....	129
3	Experimental results.....	131
3.1	Effectiveness of the subsidy schemes.....	131
3.2	Efficiency of the subsidy schemes.....	135
3.3	The crucial role of the first period of the experiment.....	137
3.4	The role of aversion to risk and beliefs.....	140
4	Conclusion.....	142

**Chapter 4: Challenges of achieving biodiversity offset outcomes through AES: Evidence from an empirical study in Southern France.....145**

	Introduction.....	145
1	Background literature and research hypotheses.....	147
1.1	Definition of ABOS.....	147
1.2	Acceptability of ABOS.....	148
1.2.1	Flexibility.....	149
1.2.2	Payment/Costs.....	150
1.2.3	Social norms.....	150
1.2.4	Attitude towards the environment.....	150
1.2.5	Trust.....	151
1.3	Performance of ABOS.....	151
1.3.1	Compliance.....	151
1.3.2	Additionality.....	152
1.3.3	Link between land use and environmental outcomes.....	152
1.3.4	Permanence.....	153
1.4	Research hypotheses.....	154
2	Materials and methods.....	154
2.1	Presentation of the case study.....	154
2.1.1	The BO project.....	154
2.1.2	The ABOS programme.....	155
2.2	Data collection and data analysis.....	157
2.2.1	Farmers' acceptability of ABOS.....	157
2.2.2	ABOS performance.....	161

3	Results and Discussion.....	162
3.1	Determinants of farmers' acceptability of ABOS .....	162
3.2	Performance of ABOS .....	166
3.2.1	Analysis of the survey of farmers engaged in the AES programme .....	166
3.2.2	Analysis of the plot selection process .....	169
4	Conclusion and Policy implications .....	171
<b>Chapter 5: Compensating environmental losses versus creating environmental gains. Implications for biodiversity offsets and AES.....</b>		<b>175</b>
Introduction .....		175
1	Literature review .....	177
1.1	Purpose difference: compensation vs conservation.....	177
1.2	Responsibility for the loss .....	179
1.3	Environmental attitude .....	180
1.4	Trust in contracting partners.....	180
2	Method .....	181
2.1	Choice experiment approach and model specification .....	181
2.2	Contract attributes.....	182
2.3	Experimental design .....	184
2.4	Data collection.....	186
3	Results .....	188
3.1	Preference for contract attributes.....	188
3.2	Analysis of preference heterogeneity .....	190
4	Discussion and conclusion .....	194
<b>GENERAL CONCLUSION .....</b>		<b>197</b>
1	Main findings .....	197
2	Behavioral approaches in agri-environmental policies. ....	203
3	The use of stated preferences and experimental methodologies .....	206
4	Limits and extensions.....	207
<b>REFERENCES.....</b>		<b>211</b>

<b>APPENDIX.....</b>	<b>227</b>
Appendix 1: Questionnaire of the TPB survey .....	229
Appendix 2: Description of the different possible cases of our model in presence of an injunctive and a descriptive norm.....	245
Appendix 3: Questionnaire of the social norm web survey.....	249
Appendix 4: Instructions of the lab experiment.....	255
Appendix 5: Main determinants of adoption of agri-environmental schemes in the literature.....	265
Appendix 6: Questionnaire of the ABOS survey.....	267
Appendix 7: Description of the variables used in the econometric model.....	277
Appendix 8: Example of a choice set.....	279
Appendix 9: Traductions en français.....	281

## TABLE OF FIGURES

Figure 1: The Theory of Planned Behavior.....	49
Figure 2: Modified version of the TPB used in this study. ....	52
Figure 3: Binomial coding of the intention variable .....	61
Figure 4: Descriptive statistics of the TPB variables .....	63
Figure 5: Influence of social norms on individual behavior .....	82
Figure 6: Variation of descriptive norm utility according to participation .....	90
Figure 7: Nash equilibria with the descriptive norm in relation with the value of p .....	92
Figure 8: Variation of injunctive norm utility according to participation .....	94
Figure 9: Nash equilibria with the injunctive norm in relation with the value of p .....	95
Figure 10: Presentation of the variation of utility between participating or not according to participation in the presence of injunctie and descriptive norms .....	97
Figure 11: Descriptive statistics of the social norm indicators .....	110
Figure 12: Total earning of groups as a function of aggregate contribution .....	127
Figure 13: Average group contribution by period in the 6 sessions of the experiment .....	132
Figure 14: Aggregate group contributions for the different treatments in the first sequence of the experiment .....	138
Figure 15: Schematization of Agri-Biodiversity Offset Schemes (ABOS) as a transaction in biodiversity offset policies. ....	148
Figure 16: Frequency of farmers according to their intention to adopt an ABOS in the future .....	162

## TABLE OF TABLES

Table 1: Description of the main variables, questions and scales used in the survey. ....	57
Table 2: List of questions and scales used in the questionnaire to evaluate salient beliefs ....	60
Table 3: Intention of farmers to adopt an AES in the next three years .....	62
Table 4: Descriptive statistics of the TPB variables .....	62
Table 5: Pearson’s pairwise correlation coefficients between variables of the TPB model. ...	65
Table 6: Analysis of the intention to adopt an AES in the next 3 years using standard TPB variables .....	66
Table 7: Average scores for outcome beliefs. ....	68
Table 8: Regression analysis of the attitude and the intention to adopt an AES in the next 5 years with outcome beliefs. ....	70
Table 9: Average score for control beliefs .....	71
Table 10: Regression analysis of the perceived behavior control and the intention to adopt an AES in the next 5 years with control beliefs. ....	72
Table 11: Average scores for normative beliefs. ....	73
Table 12: Possible indicators of the role of social norms on the adoption of AES depending the importance given to the role of expectations and beliefs on social norms .....	100
Table 13: Coding of the questionnaire variables. ....	107
Table 14: Descriptive statistics of the variable AES that integrates effective participation decisions .....	109
Table 15: Pearson’s pairwise correlation between social norm indicators. ....	111
Table 16: Logit and ordered logit estimation of participation to AES schemes for the web-survey and ordered logit estimation for the TPB survey and the web-survey pooled together .....	112
Table 17: Transposition of the context into the laboratory .....	126
Table 18: Treatments tested in each session of the experiment .....	130
Table 19: Summary of sessions and within-group comparison of treatments using chi2 and Wilcoxon paired test. ....	133
Table 20: Frequency of success of production of the public good in the first sequence of all sessions. ....	133
Table 21: Comparison of average group contributions in the first sequence of all sessions using the Wilcoxon Mann-Whitney test. ....	133

Table 22: Panel regression with random effects on group contributions in the first sequence of all sessions.....	134
Table 23: Panel regression with random effects on group contributions with all data pooled together.....	135
Table 24: Comparison of net social gains in the first sequence of all sessions using the Mann-Whitney test.....	135
Table 25: Panel regression with random effects on net social gains with all data pooled together.....	136
Table 26: Panel regression with random effects on individual contributions to the public account .....	139
Table 27: Comparison of beliefs about others' contribution between treatments in the first period using the t- test .....	140
Table 28: OLS regression on individual contribution to the public account in period 1 .....	141
Table 29: Comparison of average group risk between groups that success or fail to reach the threshold in the first period using a Mann-Whitney test.....	142
Table 30: Descriptive statistics of the survey sample compared to the Gard Reference .....	160
Table 31: Logit estimation of the intention to adopt an ABOS in the coming years.....	163
Table 32: Intensity of practice change following ABOS adoption .....	166
Table 33: Criteria quoted by farmers for farmers for the selection of plots they offered .....	167
Table 34: Average CU/ha benefits for the different level of ecological rating.....	168
Table 35: Farmers' intentions after their current contract ends regarding the signature of a new ABOS contract.....	169
Table 36: Farmers' intentions regarding their agricultural practices in the absence of ABOS .....	169
Table 37: Logit estimation of the plot selection choice. ....	170
Table 38: AES attributes, levels used and their coding.....	186
Table 39: Descriptive statistics of the survey sample .....	187
Table 40: Mixed logit estimation of choice experiment data.....	189
Table 41: Frequency of response to three questions involved in the interpretation of preference for the purpose of contracts .....	191
Table 42: Mixed logit estimation of choice experiment data.....	192
Table 43: Number of farmers according to their general opinion on biodiversity offsets .....	193



## **ACRONYMS**

<b>ABOS</b>	Agri-environmental Biodiversity Offset Schemes
<b>AES</b>	Agri-Environmental Schemes
<b>BI</b>	Behavioral Interventions
<b>BO</b>	Biodiversity Offsets
<b>CA30</b>	Chamber of Agriculture of the Gard Region
<b>CAP</b>	Common Agriculture Policy
<b>CNM</b>	Contournement Nîmes Montpellier
<b>CS</b>	Conditional Subsidy
<b>CU</b>	Compensation Unit
<b>NNL</b>	No Net Loss
<b>PBC</b>	Perceived Behavior Control
<b>PPM</b>	Provision Point Mechanism
<b>TPB</b>	Theory of Planned Behavior
<b>US</b>	Unconditional Subsidy
<b>WTA</b>	Willingness To Accept
<b>WTP</b>	Willingness To Pay



## SCIENTIFIC CONTRIBUTIONS

Le Coent, P., Préget, R. and Thoyer, S., 2014. Why pay for nothing? An experiment on a conditional subsidy scheme in a threshold public good game. *Economics Bulletin*, 34, p. 1976–1989.

Kuhfuss, L., Le Coent, P., Préget, R. and Thoyer, S., 2015. Agri-Environmental Schemes in Europe: Switching to Collective Action. In: *Protecting the Environment, Privately* (Bennett, J., ed.) World Scientific Publishing - Imperial College Press, p. 200.

Le Coent, P. and Calvet, C., 2015. Challenges of achieving biodiversity offsetting through agri-environmental schemes: evidence from an empirical study. *Presented at: Journée de la Société Française d'Economie rurale*, Nancy, 10-11 December 2015 *and accepted at the Annual Conference of the European Association of Environmental and Resource Economics*, Zurich, June 2016

Le Coent P., Preget R. and Thoyer S., 2016. Compensating environmental losses versus creating environmental gains. Implications for biodiversity offsets and agri-environmental contracts. *Presented at: 90th Annual Conference of the Agricultural Economics Society*, University of Warwick, England, 2016

Pailleux, C. and Le Coent, P., 2015. Tenir compte des normes personnelles dans les politiques agro-environnementales : une « obligation morale »? *Presented at: Journée de la Société Française d'Economie rurale*, Nancy, 10-11 Décembre 2015.

Kuhfuss, L., Préget, R., Thoyer, S., Hanley, N., Le Coent, P. and Désolé, M., 2016. Nudges, social norms and permanence in agri-environmental schemes: *Land Economics*, 92, p. 641–655.



## GENERAL INTRODUCTION

“No to technocratic ecology, yes to farmers’ common sense” – this slogan chanted by French farmers during demonstrations in 2014 reveals a strong cultural resistance of the farming community to the growing weight of environmental objectives in agricultural policies. Yet, although there is increasing evidence that farmers’ motivations for adopting (or not) pro-environmental farming practices are not exclusively driven by economic calculus, the agri-environmental policy of the European Union has not evolved much in the last 20 years. It mostly relies on regulatory measures (cross-compliance green measures) and economic incentives such as agri-environmental payments. Over the 2007-2013 financial period, total payments made by the European Union (EU) for Agri-Environmental Schemes (AES) amounted to 22.7 billion euros, and were supplemented by EU member states for an equivalent amount<sup>1</sup>.

The underlying assumption is that compensating farmers for the additional cost of adopting pro-environmental practices is sufficient to induce a change. This approach overlooks the social and psychological forces at work in this transformation of agriculture. It has indeed resulted in disappointing outcomes. Evaluations of AES programs have shown that participation rates are low, especially in areas of intensive farming and that environmental objectives are not met (Dobbs and Pretty, 2008; Solagro, 2013). What is therefore at stake is to understand the reasons of such failure and to analyze better the drivers of farmers’ choice between different types of farming practices, which entail different environmental impacts.

Standard economic literature relies on the assumption that farmers act as standard economic agents and are willing to change their agricultural practices if they get in return a compensatory amount sufficient to cover their opportunity costs. In practice, it is observed that some farmers are extremely reluctant to switch to new farming practices even when the payment level is above additional costs and income foregone (Kuhfuss et al., 2014). Others, on the contrary, are prepared to sign an agri-environmental contract even if they are not fully compensated for their costs. There is therefore a need for a wider understanding of farmers’ rationale to participate in AES. What are the reasons for the discrepancy between predictions

---

<sup>1</sup> Financial plan of EARDF axis 2 measure 214 (agri-environment)

of the standard economic literature and actual behavior? Could the effectiveness and efficiency of AES be improved by understanding these reasons?

Behavioral economics provide a theoretical framework to address these questions: it identifies “behavioral biases” or factors, as systematic deviations of human behavior from the predictions of the rational choice theory (Shogren and Taylor, 2008) and proposes to enrich classical economic decision models by introducing these behavioral factors. The findings of behavioral economics can help designing policies which are better adapted to agent’s decision rules. Behavioral economics is increasingly being used in the policy arena. Despite this phenomenon, behavioral economics have not been much applied in the study of the adoption of pro-environmental behavior and in the design of agri-environmental policies.

The overall objective of this thesis is thus to measure to what extent farmers’ pro-environmental decisions are influenced by social and psychological factors. This better understanding of farmers’ behavior can help designing incentive schemes which are more cost-efficient. It mobilizes behavioral economics through various empirical works in the lab (experimental economics) and in the field (surveys and choice experiment).

The thesis addresses two broad questions:

- What is the role of behavioral factors in the adoption of AES?
- What is the performance of innovative AES designs and how it is affected by behavioral factors?

Addressing this issue is fundamental because basing agri-environmental policies on a better knowledge of farmers’ behavior could potentially increase the impact of incentives. It can for example provide ideas on how to modify these incentives and harness the role of behavioral factors. In addition, it will open the possibility to implement low-cost alternative intervention, such as “nudges” (Thaler and Sunstein, 2008). These approaches are needed in a context where the financial burden of the agricultural policy is recurrently contested at the European level.

Section 1 of this introduction presents a brief history of AES and the main issues they are facing. In section 2, we describe the main behavioral theories used to analyze pro-environmental behavior, including for farmers, and their growing role in the policy arena. Section 3 presents our research questions, hypotheses and the methodology we have mobilized.

# 1 AES history and main issues

## 1.1 AES brief history

The principle of AES appeared in the 80s in Europe as a response to two issues of different nature: i) the growing recognition of the negative externalities on the environment generated by agriculture intensification and ii) the need to find an acceptable rationale for farm subsidies in the WTO negotiations (Hanley *et al.*, 1999; Hodge, 2013). The possibility to include national payments in environmentally sensitive areas was introduced in the European Union in 1985 but AES, as such, were introduced in the CAP during the Mac Sharry reform in 1992. Since the Agenda 2000 reform, it is mandatory for Member States to include AES in their rural development plans, as well as cross compliance conditions. Farmers getting financial support from the CAP must comply with a set of “good agri-environmental conditions (GAEC)” in terms of soil and water protection mostly that form a reference level. AES are proposed in areas displaying major environmental issues: they propose individual contracts compensating voluntary farmers for their adoption of pro-environmental farming practices which are more demanding than GAEC. AES payments are granted annually and shall cover additional costs and income foregone resulting from the commitment made and, where necessary, may also cover transaction costs (Regulation EC/1698/2005). Payments are however not differentiated according to individual opportunity costs but are rather flat rate payment, whose amount is set using data of an “average farm” in each region. Contracts may last from 5 to 7 years.

In parallel, Payments for Environmental Services (PES) have flourished in developing countries and have been implemented on a large scale. Examples of PES include national-scale PES programs in Costa Rica (Pagiola, 2008) and Mexico (Muñoz-Piña *et al.*, 2008), PES on forest-use in Madagascar (Sommerville *et al.*, 2010) and PES for soil erosion in China (Chen *et al.*, 2009). PES definition is a subject of controversy in the literature, we however consider the reference definition of Wunder (2005). A PES is:

1. a voluntary transaction where
2. a well-defined environmental service (or a land-use likely to secure that service)
3. is being ‘bought’ by a (minimum one) ES buyer
4. from a (minimum one) ES provider
5. if and only if the ES provider secures ES provision (conditionality).

AES can be considered as government funded PES, in which a centralized public administration acts as a single buyer on behalf of the environmental service end-users (Engel *et al.*, 2008; Wunder *et al.*, 2008).

## **1.2 Issues of AES**

AES face a number of issues in their implementation. These issues have been largely studied in the economic literature. We present below a general review of AES issues that serves two purposes. First, it describes the main conclusions of standard economic approaches and helps identifying gaps on which behavioral approaches<sup>2</sup> may provide additional contributions, such as the issue of participation in AES. Second, this review highlights some of the main issues that affect AES effectiveness and efficiency. We present here especially issues stemming from information asymmetry and lack of coordination of farmers. This review is made for two reasons. First, one of the innovative designs that we study in this thesis addresses specifically one of the AES issues, namely the lack of coordination. Second, this inventory of issues serves as a framework to analyze the performance of the Agri-environmental Biodiversity Offset Scheme, one of the AES innovative design we study.

### **1.2.1 *The participation issue***

Considering that attaining high level of participation is one of the key to ensure a significant environmental impact, empirical research has analyzed the determinants of participation. The main determinants highlighted in the economic literature are: (a) farmer and farm socio-economic characteristics, (b) contract characteristics, (c) payment level and transaction costs. The underlying assumption of these studies is the standard economic approach that considers that farmers adopt an AES if their participation constraint is fulfilled, i.e. if payments are superior to the farmers' opportunity costs (e.g Moxey *et al.*, 2008). The determinants identified in the literature are therefore supposed to be factors of the farm cost function to implement the prescribed agricultural practices.

#### a) Farmer and farm socio-economic factors

Farm size, farmers' age and education are considered, in the literature, as the main farmers and farms socio-economic factors influencing the adoption of AES by farmers. More precisely, AES are generally adopted in larger farms (Morris and Potter, 1995; Wilson, 1997;

---

<sup>2</sup> We use the term behavioral approaches to include both behavioral economics and other behavioral sciences, mainly social-psychology.

Falconer, 2000a; Allaire *et al.*, 2009). Younger farmers are generally more likely to adopt AES (Morris and Potter, 1995; Bonnieux *et al.*, 1998; Wynn *et al.*, 2001; Vanslebrouck *et al.*, 2002a; Ruto and Garrod, 2009; Ducos *et al.*, 2009; Chabé-Ferret and Subervie, 2013) unless the scheme is focused on extensification practices (Drake *et al.*, 1999). Finally, farmers with higher educational levels tend to be more interested in such schemes (Wilson, 1997; Allaire *et al.*, 2009; Louis and Rousset, 2010; Chabé-Ferret and Subervie, 2013).

Attitude towards risk is also a key factor of AES participation. Risk aversion is considered to influence adoption but in two opposite ways. First positively, mainly due to income security allowed by AES payments (Fraser, 2004). Some farmers can even sell the environmental services below opportunity costs if the payment is stable and lasting to reduce income instability (Fraser, 2004; Karsenty *et al.*, 2010). Nevertheless, Slangen (1997) and Sumpsi *et al.* (1998) stated that uncertainty regarding the future of AES policy and the impact of practices on the future production may hamper farmers' participation.

#### b) Contract characteristics

Contract flexibility is an important criterion in farmers' adoption of AES. Contracts that are more likely to be adopted have a shorter duration (Bougherara and Ducos, 2006; Ruto and Garrod, 2009; Louis and Rousset, 2010; Christensen *et al.*, 2011), leave more flexibility to farmers in plot selection (Bougherara and Ducos, 2006; Ruto and Garrod, 2009) and in technical prescriptions (Bougherara and Ducos, 2006; Ruto and Garrod, 2009; Christensen *et al.*, 2011; Kuhfuss *et al.*, 2014). Besides, withdrawal ease of the program is also an important criteria for farmers' participation (Christensen *et al.*, 2011).

#### c) Payment level and costs

Payment level proposed in AES and how they relate to individual opportunity and compliance costs is a major factor to explain farmers' adoption (Brotherton, 1991; Drake *et al.*, 1999). As mentioned previously, these payments can also be perceived as a secured source of income (Wilson and Hart, 2001).

Transaction costs have also been found to have a strong impact on adoption of AES by farmers (Falconer, 2000b; Ducos and Dupraz, 2007a; Peerlings and Polman, 2009; Vatn, 2010). High private transaction costs (real or perceived) tied to AES can represent barriers for farmers' participation in AES. Asset specificity, which is specialised investment that cannot be easily redeployed for another transaction, strongly influenced transaction costs in AES.

High asset specificity leads to strong transaction costs (Ducos and Dupraz, 2007a; Rørstad *et al.*, 2007). Trust and good relationship between contracting partners also facilitates participation in AES by reducing transaction costs both before and during the transaction (Ducos and Dupraz, 2007a; Ducos *et al.*, 2009; Peerlings and Polman, 2009; Louis and Rousset, 2010).

An experience with similar practices resulting from a prior participation in another kind of AES has also a positive effect on farmers' adoption (Allaire *et al.*, 2009; Louis and Rousset, 2010; Chabé-Ferret and Subervie, 2013). This previous experience can reduce compliance and transaction costs (Kuhfuss *et al.*, 2013).

Although many of these factors could indeed be included in a cost function, the theoretical foundation for the influence of farmers' characteristics such as age or education is rather weak. The influence of these variables could well be mediated through behavioral variables that are generally not included in these studies.

Direct evidence of the role of behavioral factors in the adoption of AESs remains relatively scarce in economic literature. The main behavioral factor that has been studied is the role of preferences for the environment but mainly in social psychological literature. Often presented as the influence of attitude towards the environment, it has been shown to influence participation to agri-environmental programmes in several contexts (Morris and Potter, 1995; Delvaux *et al.*, 1999; Beedell and Rehman, 2000a; Defrancesco *et al.*, 2008; Ducos *et al.*, 2009; Mzoughi, 2011). Farmers participating in environmental associations and having nature hobbies are also found to have more positive attitude towards pro-environmental practices and are more likely to participate in agri-environmental programmes (Beedell and Rehman, 2000a). This factor seems to be mainly important for measures that require the most efforts by farmers (Delvaux *et al.*, 1999; Vanslebrouck *et al.*, 2002a).

The effect of behavioral factors on the adoption of AES has therefore not been much studied. One of the contributions of this thesis is to contribute filling this gap.

### **1.2.2 Issues stemming from information asymmetry**

Theoretical research on AES and PES in economics has mainly mobilized a contract theory perspective. The contract is seen as a Principal-Agent relationship between a seller (the farmer or land-owner) and a buyer (the State for AES and other potential buyers for PES) of an environmental service. This contractual relationship is characterized by an asymmetry of

information – agents (farmers) have more information than the agency (the State for AES) - and different objectives - farmers want to maximize their profit and the State wants to maximize social welfare. Farmers may exploit this asymmetry of information to extract informational rent (Ferraro, 2008).

Two issues arise from this asymmetry of information. The first issue is that farmers have more information on the opportunity and compliance costs (hidden information) to comply with technical prescriptions of the contract. They can therefore try to negotiate higher payments by claiming their costs are higher. Likewise, in the case of contracts with standard and constant payments per hectare, which is the general rule in AES, there is a high potential for **adverse selection** (Fraser, 2009; Chabé-Ferret and Subervie, 2013). Adverse selection leads to selecting farmers with lower opportunity costs. This may not be a problem if opportunity costs are negatively correlated with environmental benefits, but in most cases this correlation is not verified (Claassen *et al.*, 2008). In addition, a uniform payment leads to an overcompensation of farmers with lowest costs. In the worst situation, AES may attract farmers with zero opportunity costs, i.e. who would adopt the practices without being involved in the AES and are nevertheless being paid for that. In this case, windfall effect is maximum and the additional effect of the agri-environmental programme is null or very limited (Chabé-Ferret and Subervie, 2013; Kuhfuss and Subervie, 2015). Three solutions are proposed in the literature to overcome this problem: (1) acquire information on the environmental benefits that farmers can potentially offer and select them on this basis; (2) offer to farmers a menu of screening contracts; and (3) allocate contracts through agri-environmental auctions (Ferraro, 2008).

The second issue is that farmers are better informed about their actions than the buyer (hidden action) which leads to **moral hazard**. On the one hand, the seller has an incentive to deviate from the contract terms and respect his individually rational level of compliance. On the other hand, the buyer cannot force the seller to implement the Pareto-optimal outcome due to monitoring costs (Wu and Babcock, 1996). One of the possible ways to address the issue of moral hazard is to make seller's payment contingent on environmental outcomes instead of actions. These outcome or result-oriented schemes have the advantage to give a direct incentive to the seller to provide environmental services. This type of contract however transfers the risk of a lack of environmental outcome, which may be due to stochastic natural hazard, to the farmer. Farmers may not be willing to accept this risk and enter in the contract (Zabel and Roe, 2009; Matzdorf and Lorenz, 2010).

### ***1.2.3 Issues of farmers' coordination at a landscape scale***

Commonly-used uniform payment contracts, which rely on voluntary participation, do not include mechanisms to ensure spatial coordination of efforts at a landscape scale, although it is often essential to have a significant environmental impact (Goldman et al., 2007). For example, the conservation of endangered species generally requires the creation or protection of natural habitats in the shape of corridors, patches, or mosaics that usually cut across several farms (Forman, 1995). One of the main innovations proposed to overcome this lack of coordination of farmers at the landscape scale has been the introduction of an agglomeration bonus. The performance of this mechanism has been empirically tested in laboratory experiments (Parkhurst *et al.*, 2002; Warziniack *et al.*, 2007; Parkhurst and Shogren, 2007; Banerjee *et al.*, 2012) and through mathematic simulations (Drechsler *et al.*, 2010; Bamière *et al.*, 2013).

In addition to the issues of spatial coordination, another type of coordination problem occurs in presence of environmental threshold. This is when the environmental state does not improve significantly until the global environmental effort (in terms of improved practices) has not reached a sufficient area in the zone of interest (Dupraz et al., 2009). In this thesis, we will particularly test the performance of an innovative contract designed to address this coordination issue.

This section briefly highlighted issues identified by standard economy on AES. In this thesis, we intend to use behavioral approaches to address some of AES issues and to study innovative AES designs. The next section presents these approaches and how they have been applied to the study of pro-environmental behavior.

## **2 Behavioral approaches of pro-environmental decisions**

Behavioral approaches are increasingly being used to analyze pro-environmental behavior in economics. Although this is an emerging trend in economics, social psychology has already been studying pro-environmental decisions for a long time. In this section, we present the main principles of these behavioral approaches and their application to pro-environmental behavior.

### **2.1 Behavioral economics**

Behavioral economics applies insights from psychology in the field of economics. The ambition is to enrich economic models to better explain and predict human behavior. It “explores, catalogues, and rationalizes systematic deviations from rational choice theory” (Shogren and Taylor, 2008).

Mullainathan and Thaler (2000) have classified behavioral factors into three main categories: bounded rationality, bounded willpower, and bounded self-interest. Bounded rationality means that people do not have unlimited information processing capabilities (Simon, 1955) and rather use heuristics that lead to systematic biases in judgment (beliefs) and choice. For example, people may be subject to loss aversion, framing effects, endowment effects... Bounded willpower means that people may take decisions that they know are not in their self-interest (eat and drink too much, cheat their wife...) because of lack of self-control. Finally, bounded self-interest means that people have social preferences such as altruism, fairness, norms and inequity aversion (Mullainathan and Thaler, 2000; Shogren *et al.*, 2010).

How relevant is behavioral economics to study environmental matters? The assumption of rational behavior is largely tied to the existence of an active market exchange that yields an optimal allocation of resources (Arrow, 1986). Assuming this rational choice behavior may therefore be problematic in environmental matters that largely lack market-like arbitrage (Crocker *et al.*, 1998). Environmental goods are indeed often public goods whose provision has been shown to depend on many socio-psychological factors (e.g. Shang and Croson, 2009). Besides environmental issues are often associated with strong moral feelings and are characterized by a high level of complexity that lead to bounded rationality (Croson and Treich, 2014). Shogren and Taylor (2008) make the parallel between market failure and “behavior failure” in environmental economics that may lead to a new second-best problem and call for the emergence of “Behavioral-Environmental Economics”. One of the

consequences of behavioral economics has been the emergence of new policy instruments such as “Nudges” (Thaler and Sunstein, 2008). The basic idea is that behavior can be modified by subtle modification of the decision context, often referred as the choice architecture. Among the most known examples are the nudges based on social comparison to reduce energy use (Allcott, 2011) or to increase towel reuse in hotels (Goldstein *et al.*, 2008).

The interest for the role of behavioral factors in environmental economics initially started in the field of environmental valuation with the worry that psychological factors may affect stated preferences for environmental goods: hypothetical bias, starting point bias, framing bias and more (Cummings *et al.*, 1986). In the last decades, the development of experimental economics has provided a tool to test the predictions and assumptions of standard economic theory and has largely led to question many of these. One example that has strong implications in environmental economics is the extensive literature on public good and common pool resources games (e.g. Ledyard, 1995; Ostrom, 2006).

“Green nudges”, nudges that aim at promoting environmentally responsible behavior, have increasingly been tested in the last years either experimentally or in pilot interventions. Schubert (2016) proposes to classify these nudges in three categories: green nudge that capitalize on consumers’ desire to have a good self-image by making green characteristics of a product more salient (eco-labels, Prius car), green nudges that exploit people’s inclination to follow the herd and green nudge that exploit bounded willpower by purposefully setting default choices (among different goods or services) as the green one.

Another less developed field of behavioral environmental economics research is to determine how the performance of traditional incentive mechanisms recommended by environmental economics (taxes, subsidies, tradable permits...) is affected by behavioral factors, and how optimal incentives should be adjusted accordingly. The impact of bounded self-interest is a focus of interest in this literature. Ariely *et al* (2009) defines that people may have different motivations to behave pro-socially that can be divided in three categories: extrinsic, intrinsic and image motivations. *Extrinsic motivation* is any material reward associated with the pro-social behavior. This motivation is the one traditionally studied in research that only considers self-interest. Monetary incentives generally included in environmental policies target people’s extrinsic motivations. *Intrinsic motivation* is the private preference for others’ well-being often referred as “other-regarding preferences”. Examples of such motivations are pure altruism, or the preference for the environment. Finally, *image motivation* is associated with

the tendency to be influenced by others' opinion or social approval, such as the influence of social norms. These three motivations may interact with each other and influence the effectiveness of monetary incentives used to promote pro-social behavior. The most famous example is the introduction of monetary incentives for blood donation that actually had a negative impact on this prosocial behavior (Titmuss, 1970; Mellström and Johannesson, 2008). When monetary incentives have negative interactions with intrinsic motivation, they are said to *crowd out*, while if they have positive interactions they are said to *crowd in* intrinsic motivations. For example, Benabou and Tirole (2006) set up a model that determines how incentives to carry out a prosocial activity can be determined, considering that individuals are altruist and have reputational concerns, and that monetary incentives may partially crowd them out. Another example is Nyborg (2010) who analyzes cases in which environmental taxes may crowd in or crowd out moral motivations.

## **2.2 Pro-environmental behavior in social psychology**

Social-psychology is another field of social science that has extensively studied pro-environmental behavior including the case of farmers' behavior. The two most influential and empirically supported theories used in this discipline are the theories of moral motivation and the theory of planned-behavior (Turaga *et al.*, 2010).

### **2.2.1 Moral motivation theories**

At the beginning of moral motivation theories are the works of Shalom Schwartz (1977; 1978), known as the norm-activation theory. This theory, initially developed to study pro-social behavior such as helping behavior, considers that personal norms influence this type of behavior and need to be activated to have an influence. Two conditions are needed for these norms to be activated, the individual must i) be aware that his action have an influence on the welfare of others ("awareness of consequences" (AC)) and ii) the individual must feel a personal responsibility to undertake the pro-social behavior ("ascription of responsibility" (AR)). When they are activated, they create a feeling of moral obligation to undertake the behavior. This feeling can nevertheless be neutralized by other factors. Indeed adopting a pro-social behavior can sometimes be costly and an individual can "defend" himself by denying this feeling of moral obligation. It is only when the feeling of moral obligation compensates the non-moral costs associated with the pro-social behavior that the behavior is effectively adopted (Turaga *et al.*, 2010). The norm-activation theory has been mainly used to explain waste management behavior, such as recycling (Liere et Dunlap, 1978; Hopper et

McCarl Nielsen, 1991; Vining et Ebreo, 1992; Bratt, 1999). This theory has been further expanded in the Value-Belief-Norms theory (Stern *et al.*, 1999) applied to environmental action. The Value-Belief-Norms theory considers that AC and AR are shaped by general beliefs about human-environment interactions, such as the New Ecological Paradigm of Dunlap and Van Liere (1978) and a set of basic human values such as self-transcendence, self-enhancement and tradition (Turaga *et al.*, 2010). This theory seems to have a good explanatory power for environmental citizenship behaviors such as signing a petition but much less for more costly behavior such as consumer behavior, in which contextual and external factors are recognized to be more influential (Turaga *et al.*, 2010). The theory of planned behavior that accounts for these factors has taken much importance over the years.

### **2.2.2 The Theory of Planned Behavior (TPB)**

The social psychology theory that has been the most widely used in the study of pro-environmental behavior is the Theory of Planned Behavior (Ajzen, 1991). The basic principle of that theory, coming from social-psychology, is that the intention to perform a behavior is considered as the main predictor of the behavior. Intentions are considered to capture the motivational factors that influence behavior, in other words an indication of “how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behavior”. The stronger the intention, the more likely the behavior will be performed. The TPB considers three independent determinants of intention. The first is the *attitude* toward the behavior and refers to “the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question”. The second, the *subjective norm*, represents the “perceived social pressure to perform or not to perform the behavior”. The third determinant, the *perceived behavior control*, refers to “the perceived ease or difficulty to perform the behavior”.

From this initial formulation of the theory, the model has been expanded to include descriptive social norms, personal norms and past behavior (see chapter 1 for more details on this theory). It has been widely applied and empirically supported to explain a diversity of behavior including pro-environmental behavior (see Armitage and Conner, 2001 for a review). One of the advantages of this theory is that it integrates the effects of a number of behavioral factors together rather than studying them one by one as in behavioral economics (Kahneman, 2003). A second advantage is that it provides a standardized approach to elicit behavior variables in a stated-preference survey with many concrete applications and lessons

learned. Finally, this theory also hypothesizes that a set of beliefs determines attitude (expected outcomes of the behavior), perceived behavior control (expected constraints and opportunities that affect the behavior) and injunctive norms (perceived opinion of relevant other people). Eliciting these beliefs can help identifying potential levers to influence behavior change.

### **2.3 The growing role of behavioral approaches in environmental policies**

Behavioral approaches have gained considerable momentum in the last years in the policy arena. Many countries and international organizations have started to mobilize behavioral science to elaborate public policies.

The movement started in UK in 2009, with the creation of the Behavioral Insights Team, attached to the Prime Minister's office. This institution is dedicated to the application of behavioral sciences in public policies with the objectives to improve cost effectiveness of public policies that enable people to "make better choice for themselves"<sup>3</sup>. On environmental issues, this institute issued a policy publication named "behavior change and energy use" that describes a number of field trials of green nudges to reduce energy consumption. In the US, Cass Sunstein was appointed as the Head of the White House Office of Information and Regulatory Affairs (OIRA) in 2009. Since then, behavioral approaches have taken importance in US policies, formalized by Obama's presidential executive Order issued in September 2015 called "Using Behavioral Science Insights to Better Serve the American People" that strongly encourages federal administrations to use behavioral economics in policy design and implementation. The OECD runs a project called "Behavioral and Experimental Economics for Environmental Policy" that aims at using scientific insights to improve environmental policy. This project *inter alia* runs a database of behavioral economic studies for the use of practitioners and policymakers. Finally, the 2015 World Bank report "Mind, Society, and Behavior" also illustrates this trend. In France however, the use of behavioral economics still remains anecdotal. The main contribution is the report "Green nudges: new incentives for ecological behavior" published by the Centre d'Analyse Stratégique attached to the Prime minister office (Oullier and Sauneron, 2011). A call for a wider use of behavioral economics in French Public Policies was published in Le Monde in 2015 by Elsa Savourey and Cass Sunstein (2015).

---

<sup>3</sup> <http://www.behavioralinsights.co.uk/about-us/>

In the field of agri-environmental policies, behavioral science has not been much exploited so far, except in the UK. Defra is a precursor in the use of behavioral approaches since the year 2005. Defra commissioned a number of reports on the matter in order to take stock of existing literature and delineate a strategy based on behavior science. Much of the work is targeted at consumer behavior, but a specific effort has also been done on the understanding of farmers' behavior and how it could be changed (Defra, 2008). Their behavioral model, strongly influenced by the TPB, considers that behavior is influenced by *Internal factors*, which include Attitude, Habits and past behavior, *External factors*, which include market conditions, cost and traditional policy interventions based on incentives and regulations and *Social factors* that include norms. Defra considers that these different motivations need to be addressed in order to reach long term behavioral change. A concise behavioral approach is already contained within "*Securing the future*" the UK Sustainable Development Strategy (DEFRA, 2005). It argues that for successful and sustainable government interventions, there needs to be a balanced approach addressing both internal and external factors through the 4Es "Encouraging" (incentives), Enabling (facilitating through infrastructure and institutions), Engaging (influencing internal motivations) and Exemplifying (leading by implementing and communicating on success stories). Policy measures which aim is to "enable" and "encourage" rather target external motivations while policy measures which aim is to "engage" or "exemplify" rather target internal and social motivations. Finally, Defra also has investigated the heterogeneity of farmers, considering that different segments of the population will respond to different triggers (Collier *et al.*, 2010). The typology was established based on two surveys. One carried out on 683 farmers by the University of Reading (2006) based on the TPB completed by a study by Continental Research through a telephone survey with 750 farmers (Defra, 2008). Five segments, or farming styles, were identified using quantitative analysis methods:

- Custodians (23%) for which farming is a way of life deeply entrenched in their identity.
- Lifestyle choice (6%) for which farming is more of a main means of income and see farming as a source of joy.
- Pragmatist (22%) which is an intermediary category that has an emotional connection with farming but recognize the need to focus on business.
- Modern family business (41%) that operate farming as a business.

- Challenged enterprises (7%) for which farming is a burden inherited through family obligation that are resource constrained and cost sensitive.

In broad terms, “Custodians” and “Lifestylist” may react more to behavioral interventions while “Modern family business” and “Challenges enterprises” may be more reactive to monetary incentives. “Pragmatists” may be susceptible or require both types of interventions.

The behavioral approaches presented in this section have not yet been taken into account in the way agri-environmental policies are designed in Europe, especially in the design and implementation of AES. The aim of this thesis is to fill this gap and to analyze the role of behavioral factors in the performance of AES.

### **3 Research questions, hypotheses and methods**

As mentioned earlier, our research is organized around two broad questions:

1. What is the role of behavioral factors in the adoption of AES?
2. What is the performance of innovative AES design and how it is affected by behavioral factors?

For each of these two questions, we highlight our specific research questions, our hypotheses, the methodology we have used and finally how these research questions are treated in this thesis.

#### **3.1 What is the role of behavioral factors in the adoption of AES?**

This question is addressed in **part I** of the thesis. Two specific research questions are examined.

##### ***3.1.1 Research question 1: Do behavioral factors intervene in the adoption of AES?***

Our hypothesis is that behavioral factors indeed intervene in farmers’ decision to participate in AES. Although managers of a farm business, farmers are not only profit maximizers but are also influenced by behavioral factors in their farming decisions.

This research question is important at the political level, in order to design contracts that will be more easily endorsed by farmers and that may have more sustainable effects. It also has theoretical stakes that is to design decision models that would more realistically reflect

farmers' behavior. It finally raises empirical questions on how to actually measure the impact of these not easily observable factors in farmers' decisions.

The focus of our work is to analyze the participation to AES and not directly the adoption of pro-environmental practices. Our assumption is that behavior factors alone can predict pro-environmental behaviors that entail relatively limited costs such as recycling, littering, reuse of towels, but are not as good to predict decisions that entail higher costs. The adoption of new agricultural practices, such as modifying weed management practices to reduce pesticide use, may require significant investments and costs that can condition the profitability of the farming activity. We therefore assume that encouraging farmers to adopt these practices requires a combination of economic incentives and behavioral factors. Studying the impact of behavioral factors on the adoption of AES therefore seemed a more promising avenue to ultimately ensure a wider adoption of pro-environmental practices. In addition, behavioral factors that influence the adoption of AES may be different from the ones involved in the adoption of an agri-environmental practice. The adoption of AES is associated with a number of specific consequences, different from agricultural practices, which may mobilize the influence of different behavioral factors: loss of independence due to the contractual relationship, increase of administrative burden...

Several behavior factors could affect the participation in AES. In terms of bounded rationality, farmers' preferences may be context dependent and be subject to the framing of AES contracts. For example, farmers' preferences for enrolling in a contract may be affected by the framing of the AES objective that could be "to improve water quality" or to "reduce the pollution generated by agricultural activities". In terms of bounded willpower, farmers may know that adopting an AES would be in their best-interest because payment is above their costs but nevertheless may renounce because of their reluctance to undertake administrative tasks. Finally, bounded self-interest can particularly intervene in the adoption of AES with the possible influence of different factors in the adoption: social norms, personal norms for the environment... We particularly focus here on the impact of bounded self-interest on the decision to adopt an AES.

In the review of models used to predict pro-environmental behavior (see section 2 of this introduction), we point out that behavioral economics models tend to include behavioral factors one by one and therefore do not provide an integrative model of the influence of several behavior factors potentially involved in the adoption of AES. The Theory of Planned

Behavior (Ajzen, 1991) appears to be a relevant theoretical framework to identify some of the main behavioral factors at work. **In chapter 1**, we therefore apply this theory to the adoption of a weed-management AES in a cooperative of vine growers located in the Languedoc Roussillon Region. We chose this case study because it was an area in which the possibility to sign AES had just been opened in 2014, when we initiated our field work. This area is also characterized by a relatively simple set of characteristics: only one type of AES was offered and the characteristics of the vine-growing farming system are relatively homogeneous. The TPB questionnaire was implemented with 52 out of the 80 professional vine growers of the cooperative. Through an econometric analysis, we identify the main motivations involved in farmers' adoption of AES.

### **3.1.2 Research question 2: Do norms influence the adoption of AES?**

We hypothesize that norms are influential in the decision to enroll in AES. Normative influence is indeed expected to have an influence in a domain that is heavily marked by status symbols (e.g. "roadside farming", that is how farmers observe each other's practice on fields by the side of the road) (Burton, 2004b). In addition, farmers are subject to a strong social pressure from the society as a whole to adopt agricultural practices that are more respectful of the environment. Several norms may be at work in this decision : *descriptive norm*, or what the others do, *injunctive norm*, or what the others' think one should do, (Cialdini *et al.*, 1990), and *personal norms*, what one think he should do (Schwartz, 1977).

The question of the influence of norms has political implications, because interventions that take into account normative influence, such as adapted incentives or normative nudges, could be implemented. Theoretically, norms have been included in a number of decision models (i.e. Nyborg *et al.*, 2006; Benabou and Tirole, 2012) but it is questionable whether norms need to be included in models of participation to AES and how this should be done. Identifying a method to empirically determine the influence of social norm is also a stake associated with this research.

Our research strategy developed in **Chapter 2** has first been to clarify through a literature review the nature of norms, the way they influence human behavior and especially pro-environmental behavior. We then implemented both a theoretical and an empirical research. The theoretical work is based on a review of existing models that take into account social norm. We then develop a novel model based on Rege (2004) that captures the effects of both the descriptive and social norm in the adoption of AES. Our empirical work is based on a

review of the existing empirical methods for the evaluation of the effect of social norm: stated preferences and revealed preferences including experimental methods. Based on this review, we decided to privilege the use of a stated preference survey that allowed the estimation of *perceived* social norms. A fairly short questionnaire was designed so that it could be administered via internet. It was basically a simplified version of the TPB questionnaire with more in-depth questions on the role of norms. The target population was constituted of farmers located in priority watersheds, for their pollution with pesticides, in the Languedoc Roussillon region, France. The questionnaire was sent to 700 farmers located in these areas thanks to the collaboration with facilitators in charge of the promotion of agri-environmental policies in these areas. These farmers had been offered to participate in AES in order to improve water quality and were taking their decision to participate or not at the moment of the survey in 2015. Our econometric analysis is focused on determining whether norms, among other determinants, are important drivers of the adoption of AES.

### **3.2 What is the performance of innovative AES design and how it is affected by behavioral factors?**

This second question, addressed in part II of the thesis, is about 1) the analysis of the performance of innovative designs that are developed either to address current challenges of AES or to address new policy needs and 2) the identification of behavioral factors that may explain the performance of these innovative designs.

We particularly analyze two innovative designs: an AES which payment is conditioned to collective participation and an AES applied to the implementation of biodiversity offset.

#### ***3.2.1 Research question 3: Does the introduction of a conditionality on collective participation improve the effectiveness and efficiency of AES contracts in presence of an environmental threshold?***

This innovative design addresses the issue of lack of farmers' coordination in a context of environmental threshold (section 1.2.3 of this introduction). The principle of this contract is that payments are conditioned to the collective attainment of the required effort to reach the environmental threshold. We call it an AES with collective conditionality. Indeed, traditional AES, that are action-based, do not take environmental threshold into account and bear a risk for public authorities to spend public funding without any ultimate result. In order to ensure that environmental outcomes are reached at the individual level, several authors have proposed the use of result-oriented or outcome-based AES. Result-oriented schemes studied in the literature consider however that environmental results are achieved at the individual

farm level, but in the case of environmental threshold, obtaining a tangible environmental outcome generally requires a coordination of farmers' efforts.

Our hypothesis is that AES with collective conditionality improve the efficiency of public expenditure by avoiding the payment of subsidies to farmers in situations where the public good is not produced. The effectiveness of this mechanism may however be affected by two behavioral dimensions: risk aversion and beliefs on others' contribution, a sort of descriptive norm. The risk not to receive a subsidy (if the threshold is not attained) is increased but beliefs on other's contribution may also be raised by modifying the perception of the descriptive norm. We hypothesize that the influence of raising beliefs is stronger than the impact of risk aversion and that the effectiveness, in terms of participation to AES, will be improved.

We tested this new form of contract using a decontextualized laboratory experiment. This choice was made for several reasons. First, this form of contract is very innovative and could hardly be tested as such, on a pilot basis, in the field. Second, this form of contract could have been tested using stated-preference methodologies but this method would have faced the classic limitations of the hypothetical bias. Finally, we wanted to elicit risk aversion and beliefs on others' contribution, which may explain the performance of this form of AES. In the laboratory setting, this mechanism was translated into a subsidy proportional to the contributions to a threshold public good and conditional to the attainment of the threshold. **Chapter 3** presents the results of this experimental work, carried out with a population of 220 students. Existing AES programmes that have similarities with the AES with collective conditionality are first presented. The analysis of experimental results first focuses on the effectiveness and efficiency of this innovative design and, second, on the impact of underlying behavioral factors on its performance.

### ***3.2.2 Research question 4: Are AES performant to achieve the objectives of biodiversity offsets?***

Biodiversity offsets (BO) are increasingly used in environmental policies as a way to halt biodiversity losses caused by the development of infrastructure and urbanization. The principle of BO is to achieve a "No Net Loss" of biodiversity by counterbalancing residual losses resulting from a development project at one place with gains provided elsewhere. Ecological gains for offsets have so far mainly been obtained through restoration activities

conducted on agricultural land acquired for this purpose by developers. This approach however meets growing difficulties due to land availability and social conflicts with farmers.

The use of an AES, that we call Agri-environmental Biodiversity Offset Schemes (ABOS) is an emerging approach to bypass this difficulty. Indeed, compared to land acquisition, ABOS may be more easily accepted by the farming community. However, the acquisition of land allows a long-term control of land-use and agricultural practices whereas the use of ABOS does not provide the same level of control. Understanding whether AES are adapted to achieve the objectives of biodiversity offsets of “No Net loss” is fundamental to determine whether this mechanism represents an opportunity to overcome the present difficulty of implementation of BO policies. **In chapter 4**, we therefore analyzed the performance of this new application of AES.

Two conditions need to be met for ABOS to attain the expected objective. The first one is the *acceptability* by farmers of ABOS contracts proposed by developers. The second one is the *effectiveness* of ABOS. This scheme must indeed induce actual practice or land use change that lead to the expected environmental benefits of No Net loss and must be sustained over time. We hypothesize that ABOS flexibility, as compared to traditional AES, facilitates farmers’ participation and that the first condition could be met. We however argue that effectiveness issues associated with AES (see section 1.2) may jeopardize the attainment of the “No Net Loss” objectives.

The research strategy we have chosen to address this question was to take the opportunity of the existence of a large ABOS programme (1000ha) implemented in the South of France that we could analyze empirically. We carried out a survey with farmers which had been proposed these contracts (1169 farmers) in order to identify the determinants of participation in this new form of AES. The determinants included both traditional and behavioral factors, such as social norms. The effectiveness of ABOS was also analyzed through a specific questionnaire sent to enrolled farmers (40 respondents) that provided qualitative insights on the effectiveness and the efficiency of ABOS. Finally, we analyzed the plot selection process used in the implementation of ABOS and its implications on effectiveness and cost-effectiveness of the programme.

### ***3.2.3 Research question 5: Does contract framing have an impact on the participation to AES?***

AES ultimate objectives can be framed in different ways when they are presented to farmers. Our hypothesis is that the way AES are presented, and particularly the way the ultimate objective of the contract is framed may affect farmers' willingness to participate, through the mobilization of behavioral factors. This question is important to ensure that the presentation of AES by facilitators and the administration is made in a way that maximizes participation. An example of framing issue is the difference between ABOS, which aim at bringing back the environmental quality to its original level after it was damaged by human intervention, and biodiversity AES, which contributes to an increase of environmental quality. In **chapter 5**, we study whether this difference affects farmers' participation.

We first identified through a literature review behavioral factors which may explain that the difference of framing may influence preferences. We then decided to quantify these preferences through the use of a choice experiment (CE). In CEs, the choice of respondents among a predetermined set of hypothetical contracts, which differ on specific attributes, reveal preferences for these attributes. In our CE, hypothetical contracts differ on three attributes: 1) the purpose of the contract (compensation of biodiversity losses or conservation of biodiversity) and the identity of the contracting agency (public or private), 2) the existence (or not) of a collective threshold of participation for the activation of the programme and 3) the level of payment. This CE was implemented with the same population used in the survey described in chapter 4 (1169 farmers that were initially offered to participate in ABOS in 2011). The result analysis particularly aimed at quantifying the preference for the contract attributes, especially the difference of contract purpose, and at identifying reasons which may explain the heterogeneity of preferences.



## **PART I**

# **WHAT IS THE ROLE OF BEHAVIORAL FACTORS IN THE ADOPTION OF AES?**

---



## **CHAPTER 1**

### **MOTIVATIONS OF FARMERS TO ADOPT AES:**

#### **An application of the theory of planned behavior.**

### **Introduction**

Many behavioral factors are considered to affect human decision in the behavioral economics literature - time inconsistency, loss aversion, framing effects, social norms...- and could intervene in the adoption of AES. Behavioral economics analyzes the effect of these factors, often in isolation by using experimental economics. However, the main question we want to address in this first stage of the thesis is “*What are the behavioral factors influencing the adoption of AES*”. Behavioral economics could therefore not help us respond to this broad question because they focus on establishing the effect of one or maximum 2 behavioral factors at the same time. Carrying out a survey with farmers in order to explore the role of several behavior factors in the participation in AES therefore appeared to be the appropriate first step of our study.

This approach however raised questions: “What behavioral factors should be included in this survey? How could the role of these behavioral factors be evaluated through a stated preference survey? In our review of the existing models for the study of pro-environmental behavior (Cf. Introduction), the Theory of Planned Behavior (TPB) (Ajzen, 1991) appeared to be one of the prominent models which could help us address these challenges. This theory presents several advantages.

First, the TPB provides a theoretical framework to model the individual decision process that includes the combined effects of several behavioral factors as well as beliefs and intention. Since its first formulation by Ajzen, the theory has included a growing number of these behavioral factors, rather considered as motivations in this field of research. In the decision process, the theory studies the intention to perform a behavior that quantifies efforts that people are planning to exert to adopt a behavior. This variable, not analyzed in behavioral economics, helps quantifying the effect of behavioral factors before actual constraints may prevent from actually adopting the behavior. Finally, beliefs are considered to be at the origin

of the decision process. Identifying these beliefs can help identifying potential policy levers to influence individual decisions.

The second advantage of the TPB is that it provides an empirical methodology based on a set of standardized questions that has a largely documented empirical validity (e.g. Armitage and Conner, 2001; Ajzen, 1991 for a review). Although the TPB has been applied to analyze the adoption of pro-environmental practices by farmers (e.g. Beedell and Rehman, 2000; Beedell and Rehman, 1999; Carr and Tait, 1991), it has not yet been applied to analyze the participation in AES.

We therefore considered that the TPB was a relevant theoretical framework to respond to our first research question “Do behavioral factors intervene in the adoption of AES? We present in section 1 the TPB model, its links with the economic theory and the way it has been applied so far to study farmers’ behavior. Section 2 presents the methodology used in our empirical study. In section 3, we present the results of this study and finally we highlight its conclusions and limits.

## **1 The Theory of Planned Behavior**

Understanding factors which could predict people’s behavior and decisions is a central concern of social-psychology. Ajzen and Fischbein (1975, 1980) proposed the Theory of Reasoned Action a theory designed to predict and explain human behavior in specific contexts, which was later completed by the TPB. This modification of the Theory of Reasoned Action was introduced to predict actions which are not under complete volitional control, i.e. actions which do not depend only on motivation but also on a number of constraints and opportunities which are beyond the individual’s control (Ajzen, 1991). This approach of behavior is considered to fall in the family of cognitive theories (Ajzen, 1991). Cognitive theories study mental processes and information processing and their role in behavior. They apply a reductionist approach which considers that all behaviors, no matter how complex, can be reduced to simple cognitive processes (McLeod, 2007).

### **1.1 The initial TPB model**

This theory deals with factors, often mentioned as predictors, which can explain specific behavior. The basic principle is that the intention to perform a behavior is considered as the main predictor of the behavior. Intentions are considered to capture the motivational factors

which influence behavior, in other words an indication of “*how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behavior*”. Obviously the stronger the intention, the more likely the behavior will be performed. The TPB as compared to the Theory of Reasoned Action adds that the performance of the behavior is also determined by the perception of constraints and opportunities, grouped under the *Perceived Behavior Control*. In other words, however motivated a person may be he could consider that some constraints prevent him from performing the behavior.

The TPB considers three independent predictors of intention: the **attitude toward the behavior (A)**, the **subjective norm (A)**, and, the **perceived behavior control (PBC)** (Figure 1). The relative importance of these factors varies according to the context.

### **1.1.1 Attitude**

Attitude refers to “the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question”. It has always been a central concept of social psychology, to the point that this discipline was considered for long as the scientific study of attitudes (Ajzen and Fishbein, 2005). As mentioned above, the concept of attitude used in the TPB is the attitude towards a specific behavior and not a broad attitude. The most used definition is the one of Eagly and Chaiken (1993) which considers that attitude is a “psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor”. This attitude is usually elicited using a semantic differential (Osgood, 1952) to appreciate the behavior, for example: bad–good, harmful–beneficial, pleasant–unpleasant, unenjoyable–enjoyable, wise–foolish, and unnecessary–necessary. The TPB takes a cognitive approach to attitude formation using an expectancy-value model (Fishbein and Ajzen, 1975). In this approach, attitude is formed out of beliefs about potential outcomes of the behavior which are valued positively or negatively. People therefore tend to have a positive attitude towards a behavior whose outcome they judge positively and respectively for negative attitudes. Concretely, attitude can therefore be calculated out of a list of salient beliefs about the results of the behavior. For example, the result of adopting an AES may be “to receive technical assistance on the implementation of a new pro-environmental practice”. Each salient belief  $i$  is then associated with the evaluation (positive or negative) of the outcome  $b_i$  and the probability of its occurrence  $e_i$ . Attitude can therefore be calculated with the following expressions:

$$(1) \quad A = \sum_i b_i e_i$$

### **1.1.2 Perceived Behavior Control**

The fact that actual resources and opportunities do influence behavior is self-evident. The contribution of the TPB is however to consider the impact of Perceived Behavior Control (PBC) on behavior *and* intention. Basically people are influenced by their confidence in their ability to perform a behavior, which is the reason for the influence of PBC on intention. PBC is defined as “the perceived ease or difficulty to perform the behavior”. The notion is close to the concept of perceived self-efficacy of Bandura (Bandura, 1978) which is defined by “judgments of how well one can execute course of action required to deal with prospective situations”. These two notions differ in the sense that the perceived self-efficacy is more related to the internal ability to perform the behavior while the latter is rather influenced by the perceived influence of external constraints and opportunities (Armitage and Conner, 2001). Authors have also made a distinction between “perceived difficulty” to perform the behavior and “perceived control over behavior”, i.e. the perception that decision depends only on one’s will (Sparks *et al.*, 1997). The TPB also proposes an expectancy-value model for the PBC based on a set of control beliefs. Each control belief  $c_i$  is multiplied by the perceived power ( $p_i$ ) of the particular control belief to facilitate or hamper the adoption of the behavior. These products are summed in order to obtain a calculated estimation of PBC (Equation 2).

$$(2) \quad PBC = \sum_i c_i p_i$$

Constraints and opportunities can be either external (financial resources, access to land; land nature) or internal (lack of information, lack of skills).

### **1.1.3 Subjective norm**

The subjective norm (SN) is defined in the TPB as the “perceived social pressure to perform or not to perform the behavior”. Social norms are traditionally considered to include two different types: descriptive norm “what other people do” and injunctive norm “what other people think I should do” (Cialdini *et al.*, 1990, more details in chapter 2). The subjective norm of the TPB is considered as the perception of others’ opinion, and therefore a perception of injunctive norm. The subjective norm is usually elicited by asking respondents to rate the extent to which “important others” would approve or disapprove their adopting a specific behavior. The influence of others’ behavior indeed depends on the extent to which individuals identify themselves with the reference group; scholars talk about social identity (Goldstein *et al.*, 2008).

The subjective norm is also considered by Ajzen to be formed out of normative beliefs. These normative beliefs consist in the “likelihood that important referent individuals or groups approve or disapprove of performing a given behavior”. Normative beliefs can be evaluated summing for all referents the perceived opinion of the referent ( $n_i$ ) multiplied by the person’s motivation to comply ( $m_i$ ) with this opinion. For example, farmers may think that neighbor farmers are against their adoption of an AES ( $n_i$ ) but may not be motivated to comply with their opinion ( $m_i$ ).

$$(3) \quad SN = \sum_i m_i n_i$$

The initial TPB model is summarized in Figure 1:

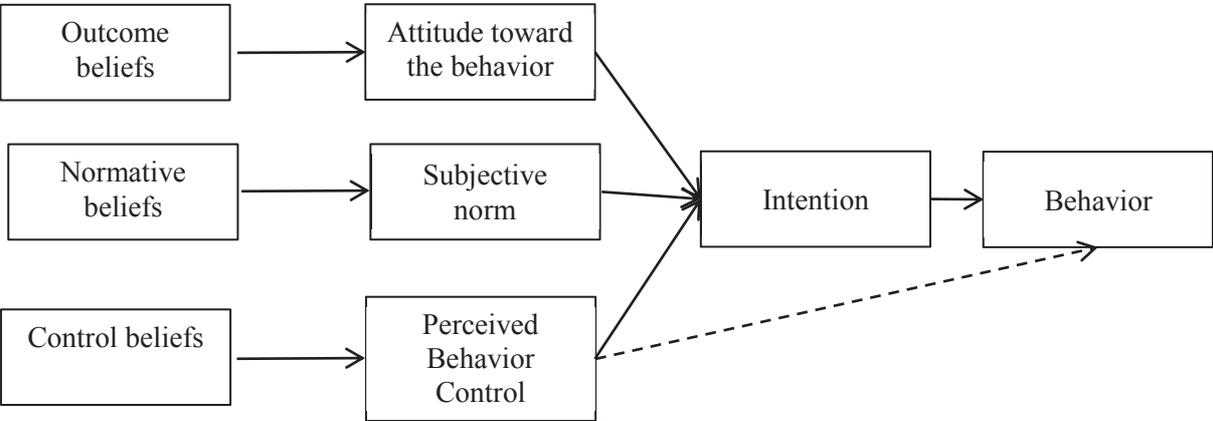


Figure 1: The Theory of Planned Behavior (Ajzen, 1991)

**1.1.4 Relative importance of TPB variables**

The theory of planned behavior has been applied to predict behavior in a very large number of contexts. Armitage and Conner (2001) provide a meta-analysis of the use of the TPB in 185 independent studies which provides information on the relative importance of the various TPB variables. Across all studies, the average multiple correlation of intention and PBC with behavior is .52 accounting for 27% of the variance. The average multiple correlation of attitude, subjective norm and PBC with intention is .62 accounting for 39% of the variance. The subjective norm-intention correlation is generally significantly weaker than the correlation with attitude and PBC.

## **1.2 Extensions of the TPB model**

Several authors including Ajzen himself have argued that the initial model of the TPB is not complete and have suggested the inclusion of other predictors in the TPB.

### ***1.2.1 Descriptive norm***

Some authors have emphasized the necessity to enrich how social norms are taken into account in the model. The definition of the subjective norm in the TPB only covers the injunctive norm and not the descriptive norm. However, research have demonstrated that this norm also have an independent influence on intentions (e.g. Ravis and Sheeran, 2003; White *et al.*, 2009). Ajzen and Fishbein (2005) finally have recommended the incorporation of descriptive norm in the TPB constructs. The inclusion of this norm in TPB studies has become a common practice.

### ***1.2.2 Personal norm***

Personal norm has been mainly studied by Schwartz (1977; 1978) with the formulation of the norm-activation theory and defined as “what a person think should be done in a particular situation, experienced as a feeling of moral obligation, anticipated guilt”. In this theory, the personal norm needs to be activated in order to trigger pro-social behavior. The activation of personal norms requires the following conditions to be fulfilled. First, the individual must be aware that his action has consequences for the welfare of others (*Awareness of consequences*). In the case of pro-environmental behavior, it means that people are aware of the impact of their actions on the environment. Second, individuals must feel a personal responsibility to undertake corrective actions (*Ascription of responsibility*), *i.e.* they don't reject the responsibility on other individuals (more details on personal and descriptive norm is provided in chapter 2). Parker *et al* (1995) also recommend to include personal norms in the predictors of behavior. However, there is question or whether its influence is direct or mediated through attitude (Lokhorst *et al.*, 2011).

### ***1.2.3 Response efficacy***

In addition to the enrichment of the model with normative dimensions, other authors have argued that pro-environmental behavior is determined by the perception of response efficacy (e.g. Bamberg and Rölle, 2003; Heath and Gifford, 2006; Kellstedt *et al.*, 2008), *i.e.* whether the individual participation will lead to actual environmental benefits. Considering the

incertitude on the link between the modification of individual agricultural practices and environmental improvement, this variable is considered important in our study.

#### **1.2.4 Habits**

Habits and past behavior are additional variables whose inclusion has been debated in the literature. Ajzen (1991) considers that past behavior strengthens the perception of control and should therefore be a precursor of perceived behavior control. However, Conner and Ermitage (1998) rather find that past behavior is directly a predictor of intention and behavior. In the case of repeated behavior, the TPB may actually not be applicable because other heuristics with simplified decision rules may be at work (Verplanken et al., 1998). In the case of the adoption of AES, contracts are usually signed for a period of 5 years. Although past experience with this type of contract may have an impact on PBC, intention and/or behavior, the frequency of repetition is not sufficiently high to consider it a repeated action which would bypass the cognitive chain of the TPB. However, farmers may be reluctant to change their agricultural practices, even if the new approach clearly has economic benefit, because of the value farmers give to the status quo (Macgregor and Warren, 2006).

Several other predictors of behavior introduced by other authors, such as anticipated regret (Van der Pligt *et al.*, 2011), self-identity (Armitage *et al.*, 1999) and anticipated emotions (Bagozzi and Pieters, 2010) have not been considered in this study. The enriched version of the TPB model we are using in this chapter is presented in Figure 2.

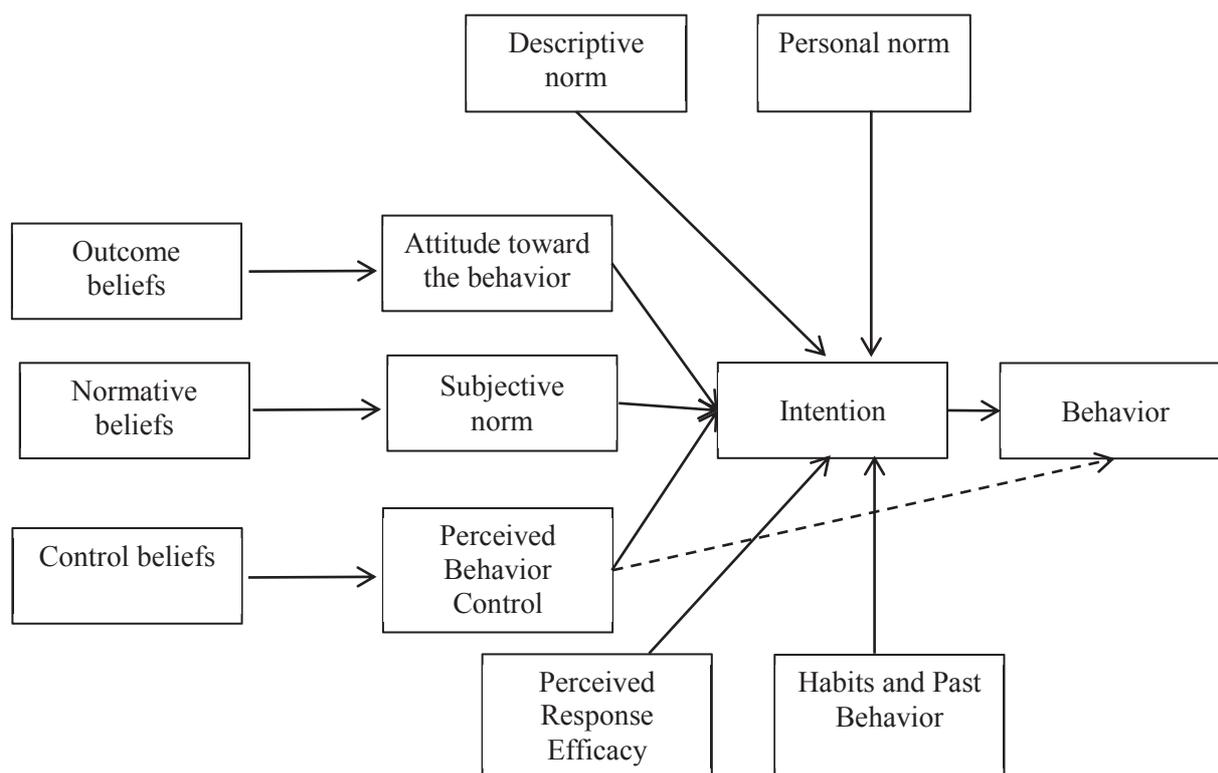


Figure 2: Modified version of the TPB used in this study.

### 1.3 Theory of planned behavior and economic theory

There are obvious links between the economic theory and the TPB. Indeed, the expectancy-value model of attitude described above, which is obtained by adding the product of subjective evaluation of possible outcomes of a behavior by the likelihood of their occurrence, is conceptually very close to the expected utility used in Economics. The concept of perceived behavior control which is defined as “the perceived ease or difficulty to perform a behavior” and calculated based on their likelihood of intervention and their perceived effect on the adoption of the behavior is also close to the constraints used in classic economic theory (Lynne, 1995). The PBC however considers both external constraints (such as capital and labor constraints) and internal constraints such as skills and information. Compared to the standard economic theory, the TPB adds the impact of social norms. However social norms are increasingly taken into account in economic models with a behavioral component (Lindbeck *et al.*, 1999; Nyborg *et al.*, 2006; Fischer and Huddart, 2008; Benabou and Tirole, 2012). The intention, which is defined by the amount of effort an individual is willing to make to perform a behavior, could also be compared to the willingness to pay, which is the maximum level of *financial* effort an individual is willing to make to purchase a good (Lynne *et al.*, 1995).

One of the main differences is that social psychology seeks to quantify attitude mainly through stated-preference methodologies while utility in the economic theory is usually a latent variable used to explain choices but that is generally not directly measured. Economics is indeed mainly concerned with ordinal comparison of utility (Litvine, 2008). However, recent developments of behavioral economics tend to enrich the specification of utility functions and therefore increase their proximity with social psychology models.

#### **1.4 TPB applied to agri-environmental issues**

The TPB and the Theory of Reasoned Action have been used in a limited number of scientific studies in the context of the adoption pro-environmental practices by farmers. These studies find different influence of the TPB predictors on the adoption of pro-environmental practices.

Fielding et al. (2005) use the TPB to understand the intention of farmers to adopt riparian zone management practices insisting on the role of beliefs in the model. They compare, using univariate tests, the beliefs of farmers with a strong intention to adopt riparian forest management with farmers who have a weak intention to do so. Strong intenders systematically have a more positive assessment of benefits and less negative assessment of costs. Normative beliefs are also linked with intention, with strong intenders who systematically perceive a more positive opinion of salient referents and are more motivated to comply with their opinion. Regarding Perceived Behavioral Control, strong intenders judged all constraints, except lack of money, as less likely to prevent them from managing their riparian zones. A multivariate regression analysis highlights that the willingness to follow the opinion of salient referents is strongly related to the intention to adopt these practices, highlighting the importance of social norms.

Lokhorst et al (2011) assess the difference of motivations for adopting subsidized and non-subsidized conservation practices. They apply the TPB to which they add personal norms and self-identity. They only use the generic indicators of the TPB variables without considering detailed beliefs. The intention to perform subsidized practices is linked to attitude, while the intention to perform non-subsidized practices is linked to attitude, subjective norms and self-identity. Perceived behavioral control was not found to be a significant predictor of behavior in either case. Personal norms have indirect effects by influencing attitudes towards conservation behavior.

Beedel and Rehman (1999; 2000b) apply the TPB to analyze hedge management by farmers in the county of Bedfordshire in the UK. They find that attitude and subjective norm are the most influential in farmers' hedge management practices. Wauters et al (2010) study farmers' behavior regarding soil conservation practices in Belgium. In this context, the attitude towards these practices is the most important predictor of the intention to adopt them while perceived behavioral control and subjective norms are not significant.

Staats et al. (2011) study the influence of TPB variables for the pesticide use by greenhouse growers in the Netherlands. Response efficacy, perceived self-efficacy and descriptive norms are added to the model. Using a structural model, attitude, perceived self-efficacy and descriptive norms are the variables which have significant influence on the intention to reduce pesticide use. However the TPB variables are not significantly linked to the actual level of pesticide use by farmers.

This literature review shows that the impact of predictors of the TPB differs depending on the context studied. It also reveals that this theory has been mobilized only to study the adoption of pro-environmental practices and not the adoption of AES. We had reasons to think that beliefs associated with the adoption of AES could differ from the beliefs associated with the adoption of pro-environmental practices. Possible outcomes of AES adoption such as financial benefits, the administrative burden (Macgregor and Warren, 2006), lack of flexibility in the choice of agriculture practices, risk of additional control by the administration, could have an impact on the motivation to sign a contract. Using the TPB to analyze the adoption of AES can be considered a novel contribution. A related study was undertaken by the University of Reading (2006) to analyze the introduction of the Single Payment Scheme in the UK and the intention of farmers to change their practices following the adoption of this scheme. This new form of CAP payment, decoupled from production, was introduced by the CAP mid-term reform of 2003. This payment scheme however does not entail a specific modification of agricultural practices and thus cannot be categorized as an AES. They apply the full TPB methodology including the evaluation of the beliefs. They confirm that attitude, perceived behavior control are correlated with the intention to change practices after adopting the SPS, with a stronger influence of the two former.

## **2 Methodology of the empirical study**

Our empirical study has several aims. It first intends to test the usefulness of the TPB theory to the study of the participation of AES. It then aims at developing a set of questions that may be used in other more classic economic studies to test the impact of several behavioral factors such as social norms. Finally, it intends to explore the motivations of farmers to participate in AES, by applying it to a specific case study.

### **2.1 The case study**

This case study concerns the adoption of an AES to reduce pesticide use which was proposed to the vine growers of the « Cave Coopérative Dom Brial » in the South of France (Baixas). This cooperative comprises 380 vine growers cultivating a total vineyard area of 2500 ha. This site was chosen because an agri-environmental program was just launched on its territory at the time when the study started in 2014. This condition was necessary to apply the TPB model to the evaluation of the intention to adopt an AES. Despite this precaution, the survey was carried out at a time when some farmers had already signed an agri-environmental contract. This has consequences on the way the TPB variables are analyzed (section 2.5).

This territory is characterized by very low rainfall (average 615 mm), which makes weed competition of paramount importance. The hydric competition with weed has a negative impact on yields, which directly affects farmers' income. Weeds can be controlled with herbicides, mechanical control or with a combination of the two. The high proportion of old vineyards in the area, with narrow vine rows, and the presence of stony soils make the use of mechanical control practices difficult. In terms of economic context, vine growers of this region face significant financial difficulties due to the crisis of the Muscat market (a sweet white wine), which historically was the main product of the cooperative. This situation gives little financial margin to farmers for the adoption of new management techniques, but makes them consider financial incentives such as AES payments with attention.

Some vineyards of the territory are located in the watershed of a drinking water abstraction. These watersheds are considered a priority due to the contamination of drinking water by pesticide, mainly herbicides, above the legal norm threshold of 0.1µg/L. The remaining vineyard area is located in the watershed of the Agly river which also presents issues of recurrent presence of pesticides (Envilys, 2013). For these reasons, an agri-environmental programme was started in the area. The AES proposed was targeted at limiting the herbicide

pressure in the watershed by modifying weed management practices. The contract proposed which we later call the “weed management AES”, requests farmers to mechanically control weeds in the space between the vine rows, while weeds can still be controlled with herbicides “under the row”, i.e. on the 20-30 cm land band situated on both side of the vine rows.

## **2.2 Sampling, survey design and administration**

The survey was carried out in two phases during the summers of 2014 and 2015. A total of 54 farmers were interviewed: 39 in 2014 and 15 in 2015. As mentioned before, the new AES programme had just been opened in 2014. A renewed AES programme, with the same technical prescriptions and payment, was started in 2015 due to the CAP reform. We therefore considered them to be equivalent. A variable *year* will be added in the regressions to control the potential impact of having surveyed farmers at two different times. This survey is only targeted at the « professional » vine growers for whom agriculture is the main activity. There are 90 “professional” vine growers in the Dom Brial cooperative and most of them are eligible to join the AES. 3 farmers out of the 54 farmers interviewed however had to be removed from the survey because they were not eligible for the participation in the AES programme. The 90 farmers were contacted by telephone and invited to participate in this survey that lasted about 1 hour. It is to be noted that some farmers could not be found on the phone, others refused because of time constraints and finally others refused to participate to a survey on this topic.

The design of the questionnaire was done in consultation with technicians of the cooperative and with a group of 4 farmers which oversees agri-environmental issues in the cooperative. This consultation was particularly necessary for the identification of the list of salient beliefs to be included in the questionnaire (see beliefs section). The questionnaire, which consisted in 55 questions, was considered complicated as compared to standard farmers’ surveys and therefore had to be administered through face-to-face interviews. In the design of the questionnaire, efforts were made to control some of the traditional biases of this type of interviews. Farmers were informed that the information collected would remain anonymous. In order to limit the declaration bias, we invited farmers to respond as faithfully as possible to this question. We also insisted on the fact that there is no “right answer” and that their response should reflect as much as possible their personal opinion.

## 2.3 Questionnaire

The survey contains a series of questions aiming at providing a quantification of the variables described in the enriched TPB model (Figure 2). Table 1 summarizes the main variables, the questions and scales used in the survey. The detailed version of the questionnaire is in Appendix 1.

Variable	Question	Scale
<b>Intention</b>	I have the intention to adopt a herbicide AES in the next 3 years	[1: Very unlikely; 7: Very likely]
<b>Attitude (A)</b>	My opinion on herbicide AES is:	[-3: Very negative; +3: Very Positive]
<b>PBC difficulty (PBCd)</b>	For me, adopting an herbicide AES is :	[1: Very easy; 7: Very difficult]
<b>PBC control (PBCc)</b>	Adopting an herbicide AES is a personal decision which depends only on my own will:	[-3: Strongly disagree; +3: Strongly agree]
<b>Cost(C)</b>	How does the payment proposed in the weed management AES relates to the cost of implementation of the required practice on you farm?	[-3: Very inferior; +3: Very Superior]
<b>Subjective norm (SN)</b>	Most people who are important to me think I should adopt an herbicide AES	[-3: Strongly disagree; +3: Strongly agree]
<b>Descriptive norm 1 (DN 1)</b>	According to you, how many farmers will adopt an AES in the next 3 years	Number of farmers
<b>Descriptive norm 2 (DN2)</b>	The fact that other farmers adopt an AES influences my decision to adopt an AES	[-3: Strongly disagree; +3: Strongly agree]
<b>Personal norm (PN)</b>	I feel a moral obligation to modify my weed control practices to improve water quality	[-3: Strongly disagree; +3: Strongly agree]
<b>Past behavior (PB)</b>	Have you already signed an AES in the past?	Yes/No
<b>Response efficacy (RE)</b>	If I adopt an weed management AES, my individual participation will have an effect on water quality	[-3: Strongly disagree; +3: Strongly agree]

Table 1: Description of the main variables, questions and scales used in the survey.

The TPB normally considers the influence of several predictors on the intention to perform a behavior and then on the behavior itself. Unfortunately, interviews could be carried out only in July, when farmers' workload is lighter. But AES participation was mostly decided in May-June. Therefore at interview time, farmers wishing to enroll for the coming year had already

made a firm commitment in June, one month before. We therefore considered a unique variable called “*Intention*”, coded from 1 to 7 according to the likelihood to adopt a weed management AES in the next 3 years, and takes value 8 for farmers who had already signed a contract at the time of the interviews.

Usual recommendation for the evaluation of attitude is to use a semantic differential which qualifies the behavior, such as “bad–good, harmful–beneficial, pleasant–unpleasant, unenjoyable–enjoyable, wise–foolish, and unnecessary–necessary” (Osgood *et al*, 1957). However, the questionnaire test phase revealed that farmers were not at ease with this type of questions and did not appreciate it. We therefore opted for a more simple approach such as the one proposed by Thurstone (cited in Allport, 1935): we assumed that attitude is simply a positive or a negative evaluation of an “attitude object”, in our case the “weed management AES”.

Perceived Behavior Control (*PBC*) is estimated using two dimensions: “perceived difficulty” and “perceived control”. We did not include in these variables the perception of the level of payment compared to the individual compliance costs. It was included as a different variable.

The subjective norm was evaluated based on the standard formulation proposed by Ajzen (1991). For the descriptive norm, we defined indicators based on the standard definition of Cialdini *et al* (1990), the perception of “what others do”. The first indicator of the descriptive norm (*DNI*) is therefore the estimation by respondents of how many farmers will adopt an AES in the next 3 years. The second indicator (*DN2*) asked farmers to self-report how much they are influenced by the behavior of other farmers. This indicator may however be biased considering that people generally underestimate the influence of descriptive norms on their behavior (Cialdini, 2007).

The personal norm was evaluated using the formulation proposed by Schwartz (1977). It refers to the feeling of moral obligation to perform the behavior.

Finally, we included indicators of the perception of response efficacy, the perception on the individual impact of adopting an AES on water quality, and of past adoption of an AES.

As much as possible, we follow the principle indicated by Ajzen (1991) to ensure that all questions used are focusing on the same behavior: “the adoption of a weed management AES”. The main exceptions are the ones that are related to the personal norm, including the awareness of consequences and the ascription of responsibility. In this case, our assumption is

that the behavior which bears a moral dimension is the modification of agricultural practices and not the adoption of the AES.

We privilege the use of 7 points bipolar scales which generally have had better statistical results in past analysis (Ajzen and Fishbein, 2008).

## **2.4 Beliefs**

The majority of TPB publications rely on a direct measure of the predictors of intention and to a much lesser extent on the evaluation of beliefs (Hardeman *et al.*, 2002). Beliefs are considered important in this study because our objective is to identify potential areas of intervention to make the behavior of farmers evolve. Ajzen (1991) insists on the importance of estimating salient beliefs through a preliminary survey of the targeted population or through discussion with focus group. Pre-established salient beliefs usually lead to poor correlation with the estimation of the behavioral factors.

We therefore elicited beliefs during a focus group discussion with farmers of the cooperative during which we conducted discussions around the three following topics:

- “What are the possible outcomes of the adoption of a weed management AES” in order to determine salient beliefs related to attitude
- “What are the constraint/opportunities which hamper/facilitate your adoption of a weed management AES” in order to determine salient beliefs related to the PBC
- “What are the key person who may influence farmers’ decision to adopt a weed management AES” in order to evaluate salient normative beliefs.

The questions used in the survey to elicit beliefs are presented in Table 2.

Variable	Question	Scale
<i>Attitude</i>	<i>What is your opinion on the possible outcome of the adoption on your farm of a weed management AES?</i>	
$e_i$	For me this outcome is :	[1: Not important; 7: Very important]
$b_i$	The fact that this outcome occurs is :	[1: Very unlikely; 7: Very likely]
<i>Perceived behavior control</i>	<i>Different constraints/opportunities may hamper/facilitate your adoption of a weed management AES. What do you think of the constraint/opportunities list below?</i>	
$c_i$	This constraint/opportunity hampers/facilitates my adoption of a weed management AES	[-3: Strongly disagree; +3: Strongly agree]
$p_i$	This constraint/opportunity will occur in case of adoption of an AES	[1: Very unlikely; 7: Very likely]
<i>Subjective norm</i>		
$n_i$	This person thinks I should adopt a weed management AES	[-3: Strongly disagree; +3: Strongly agree]
$m_i$	I wish to follow the opinion of this person on this matter	[-3: Strongly disagree; +3: Strongly agree]

Table 2: List of questions and scales used in the questionnaire to evaluate salient beliefs

The different salient beliefs which were listed during the design phase of the questionnaire are presented in the results section to avoid repetition.

## 2.5 Statistical analysis

Data are first analyzed with simple Pearson's pairwise correlations between TPB variables, which is the standard method used in the social psychology literature. We also use more complex models to analyze the influence of all variables taken together. Although the endogenous variable (the intention) and exogenous variables are ordinal, we use in first approximation standard regression analysis, and consider variables to be continuous. Although the use of standard regression on ordinal data can be criticized, it is sufficiently robust to be used in a first approximation (Norman, 2010). We used 7-points Likert scale with only extreme and central labels. The variation of intensity between the levels of the scale is therefore constant which is necessary to analyze variables as continuous. The intention variable however does not verify this rule, because we considered that the value would be coded 8 when farmers have already adopted the AES contract. In a second step, we therefore consider the intention to adopt to be a binomial variable (see Figure 3 for the coding) which we analyze using a logit model.

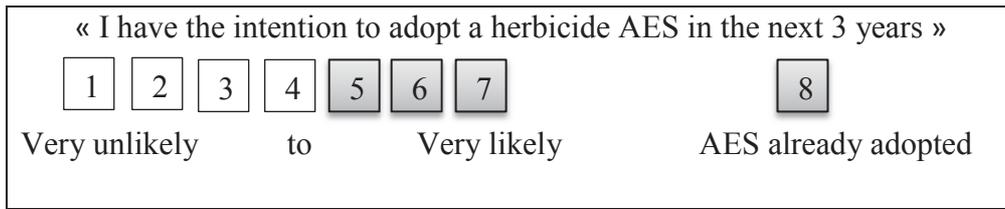


Figure 3: binomial coding of the intention variable. From 1 to 4=0; From 5 to 8=1

Finally, we also carry out an analysis in which all exogenous variables are converted into binomial variables. The statistical analysis only includes variables described in Figure 2. Socio-economic variables are not included as explanatory variables. Two reasons justify this choice: i) Ajzen (1991) considers that the inclusion of these variables is not necessary as their influence is mediated through the TPB constructs and ii) the limited number of observations imposes to limit the number of variables in multivariate analysis.

The analysis of beliefs raises a number of issues especially for the multiplication of beliefs in the expectancy-value model (French and Hankins, 2003; Ajzen and Fishbein, 2008; White *et al.*, 2010; de Leeuw *et al.*, 2015). One of them is that the multiplying scales, which are either unipolar or bipolar, may not yield a meaningful value. For example, if a farmer strongly disagrees (-3) with the fact that a constraint hampers his adoption of an AES and that he considers likeliness to occur of this constraint at a level 5, the product -15 gives a strong weight to this constraint, that was considered unimportant by the farmer. In our analysis, we therefore performed linear transformation of the scales in order to ensure that the multiplication of scales is appropriate. We therefore transformed the variable  $c_i$  and  $m_i$  from [-3 ;+3] to [1;7]. We subsequently use formula (1), (2) previously presented in section 1.1, to obtain a calculated attitude, and perceived behavior control. These calculated variables are compared with directly measured TPB variables with simple correlations in order to verify their coherence. Finally, to determine which beliefs have the most importance in the formation of the TPB variables, we regress beliefs with the respective predictor they are associated with as well as with the intention variable using OLS regressions. This method could not be used for the subjective norm because there were many missing values in cases farmers did not know the opinion of referent farmers. In this case, we therefore only comment the descriptive statistics of the various beliefs.

### 3 Results and discussion

#### 3.1 Analysis of directly measured TPB variables

Table 3 presents the frequency of farmers according to their intention to adopt an AES.

<b>Intention to participate</b>	<b>Very unlikely</b>						<b>Very likely</b>	<b>Contract adopted</b>
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>
Number of respondents	15	3	2	8	3	1	1	18
Number of respondents	28				23			
Binomial coding	0				1			

Table 3: Intention of farmers to adopt an AES in the next three years

18 farmers had already made a commitment to sign an AES when the survey was implemented. If we consider the binomial coding of the intention variable, 28 farmers (54.9%) are considered not to have the intention to adopt an AES in the next 3 years and 23 farmers (45.1%) are considered to have the intention to adopt an AES in the next 3 years. The descriptive statistics of the different TPB variables are presented in Table 4 and Figure 4.

<b>Variable</b>	<b>Scale</b>	<b>N</b>	<b>Mean</b>	<b>SD</b>
Attitude (A)	[-3: Very negative; +3: Very Positive]	51	1.16	1.39
PBC difficulty (PBCd)	[1: Very easy; 7: Very difficult]	51	3.78	1.97
PBC control (PBCc)	[-3: Strongly disagree; +3: Strongly agree]	51	1.67	1.95
Cost (C)	[-3: Very inferior; +3: Very superior]	51	-0.98	1.81
Personal norm (PN)	[-3: Strongly disagree; +3: Strongly agree]	51	1.16	1.72
Subjective norm (SN)	[-3: Strongly disagree; +3: Strongly agree]	51	0.53	1.71
Descriptive norm 1 (DN1)	Number of farmers	42	59	39
Descriptive norm 2(DN2)	[-3: Strongly disagree; +3: Strongly agree]	51	-1.69	1.78
Response efficacy (RE)	[-3: Strongly disagree; +3: Strongly agree]	51	0.57	1.80

Table 4: Descriptive statistics of the TPB variables (N number of observations – SD standard deviation)

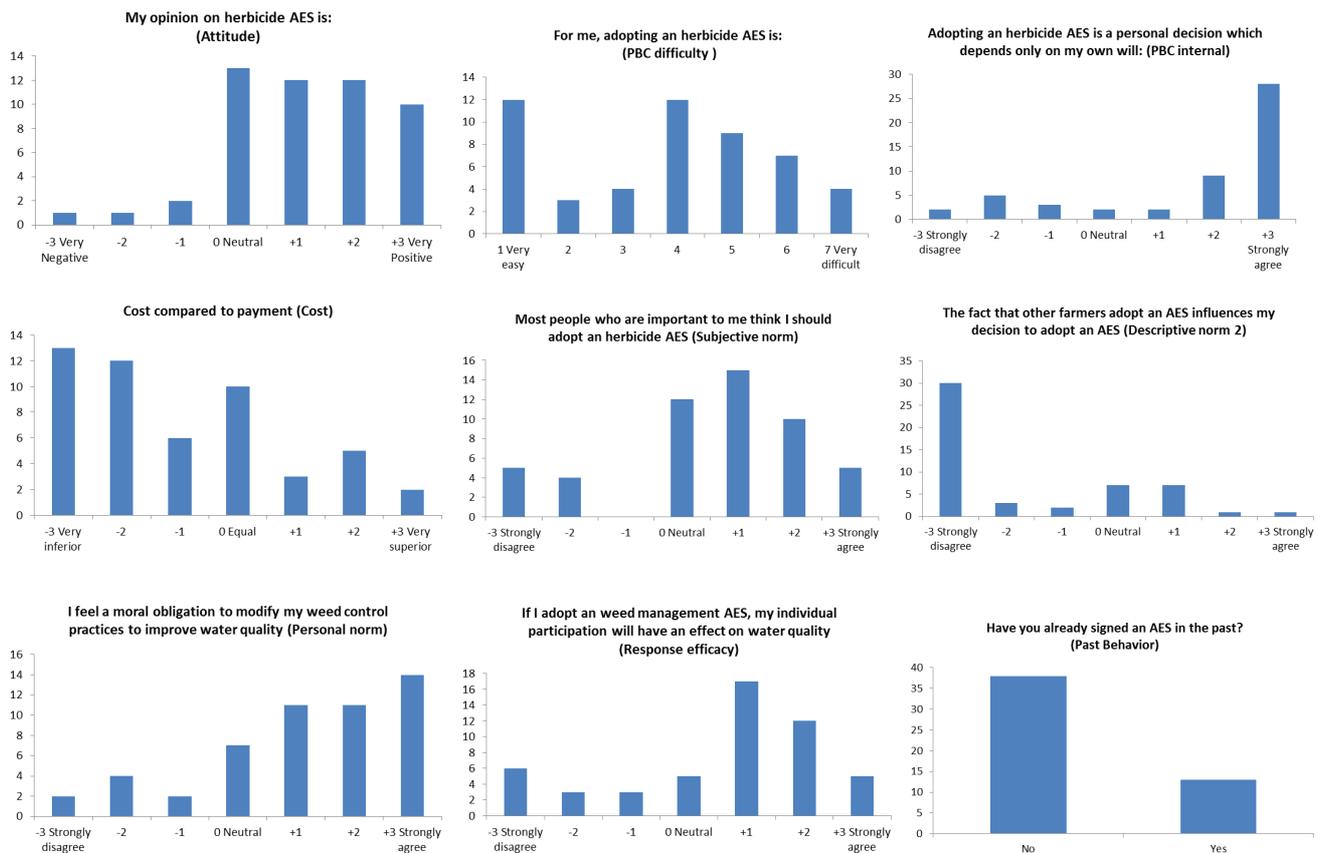


Figure 4: Descriptive statistics of the TPB variables (number of responses on y axis)

The general **attitude** regarding AES is almost uniformly positive in the population. This situation is relatively surprising considering the hostility which agri-environmental policies have faced in the farming population in the last years. The fact that the cooperative itself has taken the lead in promoting the adoption of this weed management AES may be a reason for this favorable opinion. Another explanation is a potential declaration bias, with farmers overstating their positive opinion of AES in order to please the interviewer. In this case study, it is therefore unlikely that attitude towards the AES may play a strong role in the decision to adopt an AES or not.

The **perceived behavior control** is characterized by the perceived difficulty to adopt an AES (*PBC difficulty*) and the feeling of control on decision (*PBC control*). These two dimensions of perceived control are perceived very differently by farmers. Farmers generally tend to believe that their actions are under complete volitional control as shown by the large majority of farmers who strongly agree with the statement “Adopting an herbicide AES is a personal decision which depends only on my own will”. This response is consistent with the self-identity of independent decision-maker strongly entrenched in farmers’ mindset (Burton, 2004b). The perception of the difficulty to adopt an AES is however more heterogeneous in the population with two modes: farmers who perceive no difficulty to adopt and farmers who consider that adopting represents an average level of difficulty. The perception of the **cost** (*Cost*) compared to the level of payment offered in the contract can be also used as a control variable. The average perception is that the proposed payment is below the average level of the cost of implementing such practice with however a relatively large heterogeneity. We assume that the absolute level of this indicator may be biased for strategic reasons (because the responses to this survey may influence the future level of payment) but that the relative level of the indicator among farmers, i.e. the ordering of farmers, may be accurate.

The distribution of the **subjective norm** perception follows a quasi-normal distribution centered on slightly positive opinion of “important others” on the adoption of AES.

Similar to the perception of the internal control, the self-reported influence of **descriptive norm**, i.e. how much farmers consider that they are influenced by the adoption of other farmers, is extremely low. Similar to Burton’s results (2004b), farmers consider that they are not influenced by the decision of others farmers or are reluctant to admit that they are influenced. Another approach to the estimation of this influence was to request farmers to provide an estimation of how much farmers will adopt an AES in the next 3 years. On average they consider that 59 farmers will adopt in the coming three years with a strong variability.

However, 9 farmers out of 51 did not accept to respond to this which makes the use of this variable difficult in further analysis.

The last norm variable that was estimated is the perception of the **personal norm**, i.e. the feeling of moral obligation to modify agricultural practices to improve the water quality in the territory. Responses reveal a surprisingly large proportion of farmers (71%) who agree that they ought to modify their practices, due water quality issues.

The **perceived self-efficacy** of the contribution of individual adoption of AES is declared as positive by a large majority with only about a quarter doubting that their adoption will have an effect on water quality. This figure is relatively high though, considering the usually long time elapsed before the environmental impact on water quality of an agricultural practice can be observed (Envilys, 2013).

	I	A	PBCd	PBCc	SN	DN1	DN2	PN	RE
Intention (I)									
Attitude (A)	0.38*								
PBC difficulty (PBCd)	-0.53*	-0.20							
PBC internal (PBCc)	0.37*	0.03	-0.57*						
Subjective norm (SN)	0.52*	0.58*	-0.21	0.06					
Descriptive norm 1 (DN1)	0.08	0.18	0.04	-0.07	0.31*				
Descriptive norm 2 (DN2)	-0.10	0.03	0.17	-0.31*	-0.02	0.10			
Personal norm (PN)	0.35*	0.30*	-0.18	0.21	0.35*	0.08	-0.12		
Response efficacy (RE)	0.21	0.14	-0.25	0.08	0.11	0.08	0.14	0.23	
Cost (C)	0.34*	0.29*	-0.31*	0.05	0.16	0.27	-0.17	0.04	0.02

Table 5: Pearson's pairwise correlation coefficients between variables of the TPB model. (\*refer to significance level of 5%)

The correlation coefficients between the TPB enriched model variables and the intention reveal (second column of Table 5) that relatively few variables are strongly correlated with the intention. The variables displaying the strongest correlations with intention (>0.5) are the subjective norm and the perceived difficulty to adopt an AES. In other words, the more farmers perceive that people who are important to them are in favor of their adoption of an AES and the less difficult they think it will be to adopt an AES, the more likely they are to adopt an AES. Other variables which have a lower but significant correlation are the attitude, the perceived internal control, the personal norm and the cost. The descriptive norm indicators and the response efficacy have no significant correlations with the intention. The two descriptive norm indicators have a very low correlation (0.10) which indicates that they probably refer to different psychological dimensions.

The role of the TPB variables is analyzed using multivariate regression analysis and logit estimation as described in section 1.1 of this chapter (Table 6). The two variables of control (*PBCd* and *PBCc*) which are strongly correlated and have Cronbach alpha<sup>4</sup> of 0.72, are combined in a unique indicator of perceived Behavior Control (Variable *PBC*)<sup>5</sup>.

Variables	(1)	(2)	(3)	(4)
Attitude	0.17	-0.09	-0.70	0.53
PBC	0.75***	0.54***	0.90**	2.02*
Cost	-	0.47**	1.29***	3.11**
Subjective norm	0.71***	0.62***	1.87**	3.53**
Descriptive norm 2	-	0.14	-0.03	-2.43*
Personal norm	-	0.19	1.01**	2.74*
Response efficacy	-	0.15	0.21	1.45
Past behavior	-	-1.20	-1.45	-2.31
Year	-	-1.72**	-2.74*	-3.04*
Nb. Of observations	51	51	51	51
R2	0.46	0.60	0.62	0.59
Prob>F or chi2	0.00	0.00	0.00	0.00

Table 6 : analysis of the intention to adopt an AES in the next 3 years using standard TPB variables with a standard OLS (1), the full model with an OLS (2), the logit model (3) and the logit model with exogenous variables converted as binomial. (\*, \*\* and \*\*\* refer respectively to significance level of 10%, 5% and 1%)

The complete model with all variables (2) compared to the standard TPB model (1) explains 14% more of the data variability. The effects detected are relatively stable across models. **The variables which significantly affect the intention to adopt an AES are the perceived behavior control (*PBC*), the perception of the level of payment as compared to the cost of implementation (*Cost*), the subjective norm and depending on the analysis the personal norm.**

The role of *PBC* is not a surprise: farmers who consider that they have a stronger control on their own decisions and who consider that adopting will be relatively easy have a stronger intention to adopt an AES. In the same line, farmers who perceive that costs (*Cost*) are relatively low compared to payment are more likely to adopt an AES. These variables which

<sup>4</sup> The Cronbach alpha estimates the reliability of psychometric tests evaluated with several indicators. As a rule of thumb an alpha>0.7 is necessary to pool together different indicators.

<sup>5</sup> Considering the difference of scale both in terms of scale and direction the control variable is obtained with the formula : control=((8-PBCd)+(PBCc+4))/2

are the ones that are closest to traditional economic variables are important in the decision to adopt an AES.

More surprising is the highly significant role of the subjective norm in the intention to adopt. In the studies using the TPB to predict behavior, the subjective norm is generally a weak predictor of intention (Armitage and Conner, 2001). However, the subjective norm appears as a significant predictor of behavior in studies applied to the adoption of pro-environmental practices (Beedell and Rehman, 1999; Beedell and Rehman, 2000b; Fielding *et al.*, 2005). The decisions of other farmers regarding AES (*descriptive norm 2*) however do not seem to be an important criteria in the intention to adopt an AES. The low variability of this variable in the sample can explain its limited influence. The variability of the other descriptive norm variable (*descriptive norm 1*), which focused on the perception of the number of farmers that will adopt AES, was more promising but the variable was not included because of the large number of missing values.

The analysis with the logit model reveals the effect of the personal norm on the intention to adopt an AES. The more farmers think they are morally obliged to modify their agricultural practices, the more likely they are to adopt an AES. This confirms other studies that conclude that susceptibility to environmental issues is a driver of AES adoption (Morris and Potter, 1995; Delvaux *et al.*, 1999; Beedell and Rehman, 2000a; Defrancesco *et al.*, 2008; Ducos *et al.*, 2009; Mzoughi, 2011).

The attitude which is generally a very strong predictor in the TPB (Armitage and Conner, 2001) does not have a significant effect on intention here. The reason may come from the general consensus in the area that AES is a positive policy instrument. This variable therefore cannot explain the diversity of intention in the sample.

Other variables which improve the predictive power of the TPB model in other studies, namely *past behavior* and *response efficacy*, are found not to be influential in our case study. Finally, the variable *year* shows that farmers who were interviewed in the second year of the survey display a lower intention to adopt an AES. This effect is probably due to a self-selection bias. Farmers who volunteered for the first round of interviews were probably more favorable to AES, and therefore made themselves available to participate in the survey. During the second year, it was more difficult to convince farmers to participate in our face-to-

face survey and we therefore interviewed farmers who were probably less favorable to AES. Overall, this 2-year sample gives a balanced vision of farmers' opinion and intentions regarding AES.

### 3.2 Belief analysis

In this section, we first provide descriptive statistics on outcome beliefs, control beliefs and normative beliefs. We then analyze the weight of these beliefs in the formation of the TPB variables as well as in the formation of the intention using multivariate regressions (except for the subjective norm because of missing values).

#### 3.2.1 Attitude

Table 7 presents the average scores for the importance and likeliness of occurrence of the salient outcomes associated with the adoption of AES.

	<b>Likeliness</b> [1: Very unlikely; 7: Very likely]	<b>Importance</b> [1: Not important; 7: Very important]	<b>Product</b>
Solve chemical weed control issues	2.7	3.1	11.6
Compensate costs linked to the adoption of the AES	3.4	4.8	17.7
Facilitated acquisition of weed control equipment	3.8	4.7	20.9
Increased administrative workload	4.3	4.2	21.2
Uncertainties on the capacity to control weeds	4.2	4.6	21.8
Additional technical support for the practice change	4.3	4.6	21.9
Increased risk of control by the administration	5.1	4.0	22.6
Less technical flexibility on weed control	4.3	4.5	23.8
Loss of autonomy for 5 years	4.7	4.8	26.0

Table 7: Average scores for outcome beliefs.

Among the expected outcomes of the adoption of AES, negative outcomes are the ones which are both considered most likely and important. The most prominent outcomes perceived by farmers, in terms of the “importance” and “likeliness of occurrence” are 1) the loss of autonomy for 5 years due to the commitments during the duration of the contract, 2) the loss

of technical flexibility on weed control due to the impossibility to use chemical herbicides even in the case of extreme climatic conditions and 3) the increased risk of control by the administration (Europe) not only for practices included in the contract but also for the whole farm activities. This prominence of negative outcomes is a contrast as compared to the general positive attitude expressed by farmers on the weed management AES. The first positive outcome, which comes in fourth position, is the possibility to benefit from additional technical support to modify agricultural practices. Another positive outcome: the “compensation of costs linked to the technical prescription” is very important but considered rather unlikely to happen, because the level of payment is considered too low.

A calculated attitude is computed using equation (1) presented in section 1.1. The correlation with the directly measured attitude is 0.47 which is quite low. This low correlation may be a result of our use of a general estimation of the attitude estimated by a level of favorability for weed management AES. The correlation with the intention is 0.45, which is higher than the correlation between the directly measured attitude and the intention. Table 8 presents a multivariate regression of outcome beliefs on the directly measured attitude and the intention. The only belief which has a significant effect on attitude is the beliefs that the adoption of an AES will result in the facilitated acquisition of weed control equipment. More interestingly, farmers who perceive that adopting an AES will result in less technical flexibility on weed control and loss of autonomy for the following 5 years are the farmers who are the least likely to adopt an AES. These arguments should therefore be targeted in the facilitation process for the adoption of weed control AES.

<b>Variables</b>	<b>Attitude</b>	<b>Intention</b>
Solve chemical weed control issues	-0.002	-0.008
Facilitated acquisition of weed control equipment	0.030**	-0.026
Compensate costs linked to the adoption of the AES	0.008	-0.003
Additional technical support for the practice change	0.005	0.040
Uncertainties on the capacity to control weeds	0.005	0.012
Less technical flexibility on weed control	-0.011	-0.077**
Increased administrative workload	-0.007	-0.011
Loss of autonomy for 5 years	-0.018	-0.060**
Increased risk of control	-0.012	0.006
Constant	1.366	7.561
Nb. Of observations	51	51
Pseudo R2	0.32	0.39
Prob>F	0.05	0.01

Table 8: Regression analysis of the attitude and the intention to adopt an AES in the next 5 years with outcome beliefs. (\*\* and \*\*\* refer respectively to significance level of 5% and 1%)

### ***3.2.2 Perceived behavior control***

Table 9 presents the perception by farmers of whether salient constraint and opportunities are likely to occur and may hamper/facilitate the adoption of AES. The examination of the average score for each salient belief and their product gives an indication of the main constraints and opportunities linked to the adoption of AES.

	<b>Likelihood of occurrence</b> [1: Very unlikely; 7: Very likely]	<b>Did it hamper/ facilitate adoption?</b> [1: Totally disagree; 7: Totally agree]	<b>Product</b>
Lack of technical skills	1.7	2.1	3.9
Lack of information on contracts	2.6	2.4	8.8
Collective dynamic of change	4.1	3.4	16.4
Lack of labor force	3.8	3.4	16.4
Physical difficulties for mechanical control	3.8	3.8	19.8
Lack of financial resources	4.2	4.0	21.3
Weather constraints which affect weed control	4.6	4.1	23.2
Anticipate regulatory changes	5.4	4.6	25.8

Table 9: Average score for control beliefs

Farmers state that weather hazard, especially the risk of humid weather which stimulates weed development and hampers mechanical control, is their greatest constraint for the adoption of an AES (*Weather constraints which affect weed control*). Coming second, there is the lack of financial resources. Converting to mechanical control requires investments in specific equipment that not all farmers can afford, even when benefitting from the AES payment. The third constraint is the physical constraint for weed management such as the narrow space between vine rows, the presence of heavy clay soils or of soils with a lot of stones. Interestingly the most strongly felt control belief is an opportunity: AES are considered a way to anticipate changes in regulation. Many farmers consider that the threat of a change in pesticide regulation is a factor facilitating the adoption of AES. It indeed represents a way to be financially supported to adopt a practice expected to be mandatory in the near future. Interestingly, technical skills and the information on contracts are not considered to be a limitation for the adoption of AES by farmers.

The calculated control is computed using equation (2). The correlation with the directly measured *PBCc* is -0.44 and 0.43 with *PBCd* which is relatively low. The correlation with the intention is of -0.56. The multivariate regression analysis presented in Table 10 intends to determine the constraint and opportunities that were the most influential in the formation of the control variables (*PBCc* and *PBCd*) and in the formation of the intention.

Variables	PBCd	PBCc	Intention
Lack of labour force	0.038	-0.023	-0.019
Lack of technical skills	0.093	-0.009	-0.030
Lack of information on contracts	0.048**	-0.031	-0.073**
Lack of financial resources	0.009	-0.001	-0.068***
Weather constraints which affect weed control	0.011	-0.008	0.000
Physical difficulties for mechanical control	0.003	-0.035	-0.025
Anticipate regulatory changes	0.014	-0.008	0.033
Collective dynamic of change	-0.033	0.014	0.031
Constant	2.036***	3.217***	6.189***
Nb. Of observations	51	51	51
Pseudo R2	0.33	0.30	0.38
Prob>F	0.02	0.05	0.01

Table 10: Regression analysis of the perceived behavior control and the intention to adopt an AES in the next 5 years with control beliefs. (\*\* and \*\*\* refer respectively to significance level of 5% and 1%)

The regression of beliefs on the two indicators of PBC yields very limited results. The only significant result is that farmers who consider they have a lack of information on AES contracts are more likely to consider that adopting an AES is difficult. The regression on the intention confirms that this constraint is correlated with a limited intention to participate. Although this constraint is generally considered to be of low importance, farmers who consider it as an important constraint are more likely not to engage in an AES. More interesting is the fact that farmers who consider that financial constraint is problematic for AES indeed are less likely to adopt an AES. For them, payments included in AES may not cover the full cost of the change of agricultural practice, and oversee the investments required for the mechanical control equipment.

### 3.2.3 Subjective norm

This section presents salient normative beliefs, i.e. farmers' perception of the opinion of referent people and how farmers think to be influenced by their opinion. Considering the importance of subjective norms in the decision to adopt an AES (section 3.1), this analysis provides insights on the referents who could be targeted in communication campaigns to strengthen participation in AES. Table 11 presents average scores for normative beliefs. The particularity of normative beliefs is that many farmers did not respond to "others think I

should adopt” when they considered that this salient referent did not have an opinion or that they did not know their opinion. Consequently, there are many missing values (particularly for children and parents). In this particular section, we therefore only comment on the average values of the two indicators of normative beliefs as there is not enough data to perform a regression analysis.

	<b>Others think I should adopt</b> [-3: Strongly disagree; +3: Strongly agree]	<b>Number of respondents</b>	<b>I wish to follow the opinion of this person</b> [-3: Strongly disagree; 3: Strongly agree]	<b>Number of respondents</b>
Children	1.33	15	-0.13	24
Parents	0.61	23	-0.7	27
Spouse	1.65	31	0.47	36
Neighbour farmers	0.13	31	-1.38	39
Referent farmers	0.89	38	0.53	38
Technician of the cooperative	2.19	47	0.78	50
Board members of the cooperative	2.13	46	0.55	49
Technician of pesticide company	-0.88	32	-1.33	39
Local politicians	1.12	34	-1.42	43
Neighbors (non farmers)	1.32	34	-0.86	44

Table 11: Average scores for normative beliefs.

This analysis highlights that the board members of the cooperative and its technicians are both the most important referents and the most favorable to the adoption of AES. However, this opinion is quite uniformly shared (in our case study) and therefore may not be a good predictor of the choice to adopt an AES. The picture would have probably been different if we had had different territories in our sample with different levels of implication of the cooperative in the agri-environmental programme.

A second group of important referents are spouses and referent farmers. They are both considered important in the decision to adopt an AES. The opinion of referent farmers is however more mixed. Referent farmers change from one farmer to the other but are relatively few in the cooperative. Targeting these few referent farmers may therefore be a cost-effective

way to influence adoption, through their role on the subjective norm and the intention to adopt AES. Conversely, the opinion of neighbor farmers is considered among the least favorable to AES and also among the least important one. In their responses, farmers emphasized that the opinion of other farmers matters but only the ones who are considered referent ones. This result was confirmed in informal interviews with cooperative staff who insisted on the prescriptive role of some of “leader” farmers.

Finally, people who are outside the agriculture realm such as local politicians or neighbors (non-farmers) are considered to generally have a positive opinion on the adoption of AES but are not considered important in farmers’ decisions.

## **4 Conclusion and discussion**

In order to understand key behavioral factors influencing the adoption of AES, we apply the Theory of Planned Behavior to the case study of a wine cooperative in which an AES to reduce herbicide use has been opened in 2015. We use an enriched version of the TPB that includes the standard TPB predictors of behavior, attitude, perceived behavior control and subjective norm, and additional variables considered to be relevant in pro-environmental behavior: descriptive norms, personal norms, past behavior and perceived response efficacy. We also use the expectancy-value model in order to identify beliefs that affect the attitude, the perceived behavior control and the subjective norm.

This survey carried out with 51 farmers gives some evidence on the importance of different motivations in the decision to adopt an AES. As could be expected, traditional economic motivations do influence participation to AES. The perceived behavioral control and the perception of costs, as compared to payment proposed, are indeed important drivers of AES adoption. In simple terms, farmers who have the lowest cost and that do not perceive strong constraints are the ones more likely to adopt. The constraints and negative outcomes associated to AES that seem to be mostly important in the adoption are: the lack of technical flexibility in weed control, the feeling of loss of autonomy, financial constraints and lack of information on contracts.

The injunctive norm and the personal norm have a significant role in the intention of farmers to adopt an AES. Farmers who are the most likely to adopt:

- believe that people important to them support their adoption of AES,

- feel a moral obligation to change their agricultural practices to improve water quality.

The importance of these behavioral factors confirms our hypotheses that behavioral factors and especially norms have a role in AES adoption.

The study of normative beliefs gives more insights on the people who actually exert the injunctive norm. The opinion of cooperative board members and technicians seems to be the most influential opinion. Spouse and key farmers, who could be called referent farmers or leaders, also seem to have an important role. The role of neighbor farmers is however considered minimal in farmers' decisions. Considering the importance of injunctive norms on the opinion of farmers, focusing communication and extension efforts on these categories of population may be key to ensure a more widespread participation in AES. The use of social network methodologies may be a way to identify more precisely people that are the most influential in a given context.

The theory of planned behavior faces a number of limits. The first one is the fact that it relies fully on self-reported answers provided in questionnaires. The main concern is that social desirability bias may affect responses and the overall validity of the model. One of the main concerns is the difference between self-reported behavior and actual behavior. Several studies have indeed found that self-reports of behavior are unreliable as compared to real behavior especially for behavior which are considered socially sensitive such as for example tax-evasion (Hessing *et al.*, 1988). In our study, the bias on self-report of behavior is limited because information on the adoption of AES was available. Biases on self-declared TPB variables, that we tried to control, cannot be fully avoided and are a limit of this theory.

The second limit relates to the causal nature of the TPB model. Although several meta-analysis have confirmed the capacity of the TPB to explain the variability of behavior in various contexts (Ajzen, 1991; Armitage and Conner, 2001), the causality of the TPB model on behavior has not been clearly established. First, most studies which use the TPB come from non-experimental surveys which are treated with correlation statistics. Second, the independence of the effect of the TPB variables is questioned in several studies (Giger, 2008). This situation has led many authors to recommend the use of experimental method to confirm the causal nature of the TPB (e.g. Conner and Armitage, 1998; Manstead and others, 1996; Armitage and Conner, 1999) which has not yet much happened except for rare exceptions (Litvine and Wüstenhagen, 2011). Using experimental methods by randomly applying

treatments that separately influences TPB predictors and verify the impact on intentions and behavior could be an extension of this work.

Besides the limits of the TPB methodology, our study is subject to a number of limits. The first one is that the test of the questionnaire with farmers imposed us to simplify some aspects of the TPB considered too complicated. For example, we did not use a semantic differential to quality the attitude which is normally a standard practice. Considering that our objective was to identify behavioral factors that may intervene in the adoption of AES, the reduced attention to the qualification of the attitude is not a major issue.

Finally the main limit of this study is the limited size of our sample. In order to address that limit, we considered to expand the sample using the same questionnaire. This approach would have been extremely time-consuming considering the complexity of the questionnaire that required face to face interviews. We therefore decided to rather focus our interest on the study of social norms, which seemed to be an important driver of adoption, and to conduct an empirical study based on a simplified version of the TPB questionnaire. This work is presented in chapter 2.

## CHAPTER 2

### DO SOCIAL NORMS INFLUENCE THE ADOPTION OF AES?

#### Introduction

Have you ever been in a foreign country and felt that you were doing something disapproved by people in the street (holding hand between men and women in the middle-East, smoking in public places in the United States...)? Did you change your behavior after noticing? If you have responded yes to these questions it means you have been exposed to a social norm new to you and that you have adapted your behavior to it. The social sanction imposed by people around you has made you change a behavior that you would otherwise consider to be in your best interest.

There is a growing interest in the field of economics on the role of social norms in human decisions. Analyzing the role of social norms in human decisions has traditionally been the domain of sociologists and social psychologists. In “Social Norms and Economic Theory”, Jon Elster (1989) advocates for surpassing the oldest cleavage of social science between the *Homo economicus* and the *Homo sociologicus* visions; the former that considers that humans are only pulled by instrumental rationality and the prospects of future rewards while the latter posits that they are only pushed by social forces. Put in a simple way, social norms can be defined as informal rules that an individual thinks he should follow, based on his perception of the opinion and the action of the people he interacts with. This definition is not incompatible with instrumental rationality and economic models have recently tried to introduce social norms to understand how they affect predictions.

Taking into account social norms in economic models and in the design and implementation of public policies is fundamental as they might interact positively with laws, regulations and monetary incentives but may also reduce or even counteract their effects (Cialdini, 2007). Social norms are sometimes considered as costless ways to ensure cooperation and the provision of a number of public goods. “*Good social norms solve collective action problems, by encouraging people to do useful things that they would not do without the relevant norms. Consider voting, littering, behaving courteously, keeping promises, cleaning up after one’s dog, writing tenure letters, and doing one’s share of administrative work*” (Sunstein, 1996).

Without social norms, coercion or economic incentives—requiring large public spending—would be required to ensure that collective action problems are solved. “*Norms of honesty, loyalty, reciprocity and promise keeping, to name but a few cooperative norms, are crucial to the smooth functioning of social groups*” (Bicchieri and Muldoon, 2014). Conversely, if norms are inadequate such as for example the widespread farmers’ norm of keeping a field “clean” of any weed, which implies high herbicide use with adverse effects on water quality, they can generate “public bad” and hamper the effectiveness of public policies. The question of the role of social norms in environmental matters is increasingly investigated. Do they facilitate or do they hinder the adoption of pro-environmental behavior? How can they be mobilized to improve the effect of environmental policies? How do they interact with more classic public instruments such as economic incentives?

As we highlighted in chapter 1, social norms may also be at play in the adoption of AES and pro-environmental practices. It indeed requires farmers to move from a social value of “productivist” to a “post productivist” social value that includes roles such as conservation managers (Burton, 2004b). The importance of “roadside farming”, that is to say, how farmers observe each other’s practice on fields on the side of the road and how it influences their decisions has been highlighted in several studies (Burton, 2004b). The lack of considerations for the role of norms may explain the limited participation of farmers to these schemes, which is partly responsible for their reduced effectiveness. In this chapter, we therefore intend to respond to our research question 2: “Do social norms influence the adoption of AES?”. This question raises theoretical issues, for the understanding of the effect of these norms on AES, as well as empirical issues, for the quantification of these effects in the field. We intend to address both dimensions in this paper. Understanding the role of social norms is crucial, as interventions could be modified to harness the role of social norms or avoid its negative effects. This would ultimately improve the effectiveness of agri-environmental programs. Interventions using normative influence has indeed already proven to have significant effects in other field such as energy use (Schultz *et al.*, 2007) or alcohol consumption in colleges (Berkowitz, 2004).

This chapter is presented as follows. The first section explores the definitions of social norms and the mechanism through which they influence human decision. In section 2, we review the existing theoretical models that take into account the role of social norms in pro-social behavior, with a focus on pro-environmental behavior. Based on this review, we propose a theoretical model of the influence of social norms on the adoption of AES. We then present in

section 3 a review of empirical methods to analyze the role of social norms and the empirical approach we have used. Finally, we present the results of our empirical study. In the last section, we conclude on the political implications of this study.

## **1 What are social norms?**

### **1.1 Definitions of social norms**

Social norms are the bread and butter of sociology. Emile Durkheim (1925) considers that an individual is influenced by norms that define the good and the evil of the society in which one lives. He assimilates progressively, through a socialization process (family, school, work...), what the group considers as “normal” or “abnormal”. Social norms are therefore about how members of the group one belongs to influences his action. These actions are either prescribed or proscribed, “*don’t do or do X*”, without considering, as usual in economics, the expected outcomes of this action (Elster, 1989). They are a sort of informal law system implemented at the level of a group (Cialdini and Trost, 1998).

Bicchieri (2006) considers that social norms “refer to behavior, to actions over which people have control, and are supported by shared expectations about what should/should not be done in different types of social situations”. This definition introduces three important concepts. First, norms can only exist when there are common expectations about the appropriate behavior. If these expectations are not sufficiently widespread they cannot gain the status of norms. They require a certain form of consensus. In her views, social norms are “the unintentional and unplanned outcome of human interaction”. Second, being based on expectations, these norms are subjective and go through the prism of perceptions. We will come back to the importance of that particularity later on. Third, different norms apply to different contexts, they are context dependent. In other words, norms specify the most socially appropriate action in a particular context (Kimbrough and Vostroknutov, 2013).

An important problem in public policies is that norms can be either socially beneficial or not, in the sense that they can either contribute to social welfare or on the contrary hamper social welfare. They can either promote pro-social or anti-social activities. Different norms can even apply to the same context that can sometimes be conflictual. Going back to the example of a farmer who has to choose his weed control practice, the norm that prescribes to keep the field as clean as possible and the one that proscribes to pollute the environment are conflictual and

a farmer may be more subject to one or the other, depending on the context and the social group he refers to.

Bicchieri (2006) differentiates social norms with conventions, such as “driving on the right side”. She argues that following convention is directly in the individual’s interest: private and social interests are directly aligned. Conventions can therefore be modeled as coordination games with multiple equilibria. Once an equilibrium has been reached, players have no interest to deviate from it. According to Bicchieri (2006), on the contrary, the action that social norms impose to adopt is almost never in the immediate interest of the individual who has to conform (if benefits from conforming to the norm or from not infringing it are not considered) . There is a discontinuity between individual’s self-interest and the interests of the group that supports the social norm. She argues that without social norm, the actions concerned by the norm are generally not the equilibrium of a mixed-motive game. However, the conformity incentives brought by social norms transform the initial game into a coordination game.

## **1.2 Reasons to conform to social norms**

Three different reasons for conforming to social norms are mentioned in the literature: expectations of social rewards and/or punishments (henceforth social incentive rationale), the behavior of others may represent an information of what is likely to be an effective action (henceforth social information rationale) (Thøgersen, 2014) and finally people may follow others because it is a costless way to take decisions (henceforth social heuristics rationale) .

The **social incentive rationale** is generally considered to stem from costs associated to the non-conformity to social norms. Social sanctions may produce unpleasant feelings that are anticipated by people and taken into account in behavior choice (Sunstein, 1996). This perception of social sanctions is heterogeneous in the population (Kimbrough and Vostroknutov, 2013). The importance of the social incentive may be so strong that some people may adopt a behavior only out of fear of social sanction, with no personal value attached to the action at stake or even find the action illegitimate. As mentioned above, in terms of game theory this social incentive modifies the game and may change its equilibrium. This perspective is easily compatible with standard economic theory. Before adopting a behavior, people compare monetary and emotional costs and benefits associated with this behavior and rationally decide what is in their best interest.

The **social information** rationale implies that the observed behavior of others brings information about the appropriate action. People may consider that others possess private information. The observation of chosen actions by others may reveal private information that is useful to take an optimal individual decision (Manski, 2000). For example, students may observe the result of schooling choices of other students that surround them in order to determine their optimal decision. This phenomenon is sometimes mentioned as informational learning. Although this may be a social interaction, Bicchieri (2006) argues that this cannot be considered a social norm because it does not entail a social pressure to follow the others.

Bicchieri (2006) finally argues that many times people follow **social heuristics**, or simple decision rules, rather than weigh thoroughly costs and expected benefits. They follow social norms because they don't spend much time thinking about the best action unless they are sufficiently motivated, that is to say if decisions have high personal importance. This type of mechanism only applies to decisions that have very little cost implications. In the case of a farmer choosing an agricultural practice or choosing to enter in an agri-environmental programme, the issues at stake are very significant, like the economic profitability of the farming activity. It is therefore likely that social norms rather intervene through a thoughtful cost-benefit analysis, which may however include costs and benefits associated with social norms. We therefore rule out social heuristics in this behavior.

### **1.3 Descriptive and injunctive norms**

Cialdini et al. (1990) propose a division of social norms, taken up by many authors: descriptive norms and injunctive norms.

The descriptive norm is what is typical or normal, i.e. what most people do. It mainly provides information about what will likely be an effective action "if everyone is doing it, it must be a sensible thing to do". It provides an information advantage and a decision shortcut when choosing to behave in a given situation.

The injunctive norm refers to what constitutes morally approved and disapproved conduct, i.e. what ought to be done. Injunctive norms influence people because they are the promise of social sanctions/rewards. Because actions that are approved are often the ones that are observed, there is often confusion between the two.

Although both norms may influence behavior, they are not in force at all times and in all situations. Norms need to be activated in order to have an effect and this requires the norm to

be made salient, *i.e.* attention needs to be focused on this particular norm. In presence of conflicting norms, the influential norm is the most salient one in a given situation (Cialdini *et al.*, 1990).

Bicchieri (2006) considers that descriptive norms, as such, are not social norms unless people think that they are expected by others to carry out the common behavior observed in the society. Although based on a similar distinction of norms, she proposes a slightly different theory. She argues that two types of expectations are involved in social norms: empirical expectations, or what we believe others do (a sort of subjective descriptive norm), and normative expectations, what we believe others think ought to be done (a sort of subjective injunctive norm). People have conditional preference for fulfilling the norm, provided empirical expectations and normative expectations are met. In other words, people would prefer to follow a social norm on condition that (a) they expect others to follow it and (b) they believe that, in turn, they are expected by others to follow the norm. If these two conditions are not simultaneously present, there is not really a social norm. These two theories are presented in Figure 5.

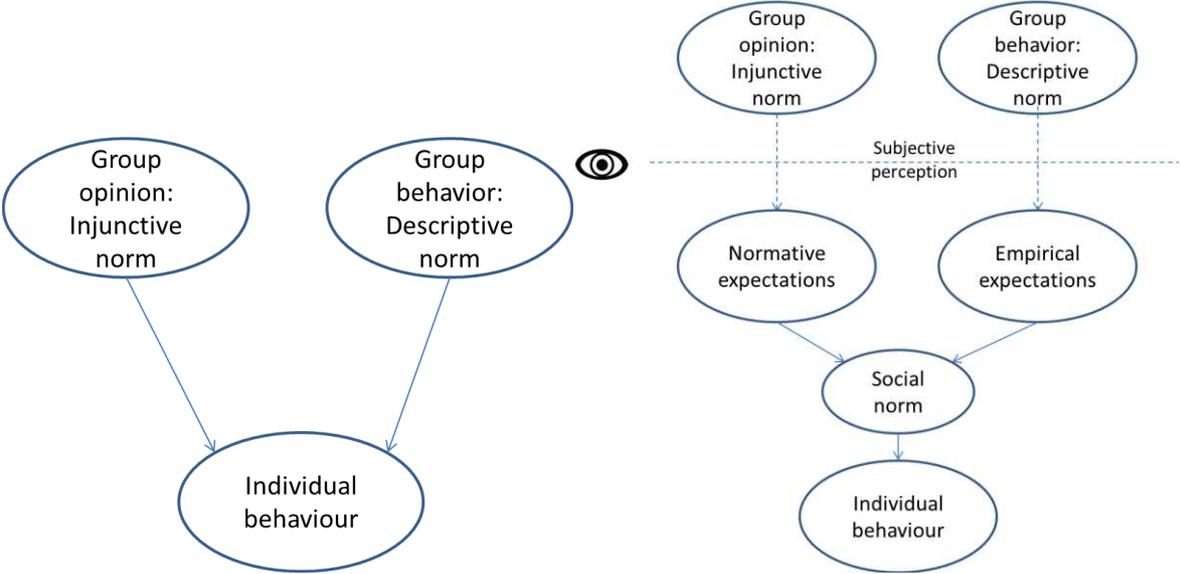


Figure 5: Influence of social norms on individual behavior according to Cialdini et al (1990) (left) and according to Bicchieri (2006) (right)

**1.4 Importance of subjective beliefs**

Bicchieri’s definition of social norms insists on the role of subjective beliefs. The importance of perceptions is also emphasized in the definition of subjective norms proposed by Ajzen (1991) in the Theory of Planned Behavior (TPB): perceived social pressure from important

others to perform or not to perform the behavior. The fact that social norms do have an influence through the prism of subjective perceptions has interesting consequences. It means that political interventions may intervene on perceptions instead of social norms *per se*, which is considerably easier. This may be particularly effective because sometimes beliefs may be inaccurate (Bicchieri, 2006). Beliefs about the norm may diverge from the actual norm in different manner: pluralistic ignorance, false consensus and false uniqueness (Berkowitz, 2004). Pluralistic ignorance occurs when most people believe that others behave or think differently than the way they do when in fact they are not. For example, most college students drink moderately but think that most college students drink more than themselves. False consensus is the incorrect belief that others behave or think like you, particularly for anti-social behavior. For example, farmers who use a lot of pesticides may consider that the others behave in the same way. False uniqueness occurs when people believe that they are fewer than they really are to have a virtuous behavior or virtuous actions. These people may therefore be at risk to abandon their behavior due to sense of exclusion. Borsari and Carey (2003) review 23 studies that confirm that these misperceptions are often largely involved in the overuse of alcohol at college. This phenomenon also occurs in other type of behavior such as cigarette smoking, illegal drug use, sexual assault and homophobia (Berkowitz, 2004) and may well have a role in the adoption of pro-environmental practices. These misperceptions are often due to the fact that a minority of individuals has a highly visible negative behavior whereas responsible behavior is much less visible.

## **1.5 Social identity**

The definition of the subjective norm used in the TPB also emphasizes that people do not refer to anyone but rather to “important others”. The influence of others’ behavior depends on the extent to which individual identify with the reference group; scholars talk about social identity. Several studies have highlighted that people are more influenced by the behavior of others who share characteristics with them such as age (Murray *et al.*, 1984), personality attributes (Carli *et al.*, 1991) and gender (White *et al.*, 2010), and also others who are spatially closer to the participants (Goldstein *et al.*, 2008).

## **1.6 Personal norms**

Another type of norm is often mentioned along with social norms: “personal norms”, sometimes mentioned as “moral motivations” or “moral norms”. Contrary to social norms that are based on interpersonal relations, personal norms are related to individual expectations.

Schwartz (1977) defines personal norms as “what a person think should be done in a particular situation, experienced as a feeling of moral obligation, anticipated guilt”. Personal norms are therefore complied with because of internal reasons and incentives to comply with the norm are fully self-administered. In his taxonomy of norms, Thøgersen (2006) highlights that differences between these norms essentially lie in their different degree of internalization: personal norms being fully integrated while social norms are rather external. According to Schwartz (1977), who analyzed the influence of norms on pro-social behavior, personal norms need to be activated in order to trigger pro-social behavior. The activation of personal norms requires the following conditions to be fulfilled. First, the individual must be aware that his action has consequences for the welfare of others (*Awareness of consequences*). In the case of pro-environmental behavior, it means that people are aware of the impact of their actions on the environment. Second, individuals must feel a personal responsibility to undertake corrective actions (*Ascription of responsibility*), *i.e.* they don't reject the responsibility on other individuals. For example, an Indian may not feel that he needs to act to reduce carbon emissions because he considers this is the responsibility of people of developed countries.

We have described in this first section the important concepts associated with social norms and the mechanism through which they have an impact on behavior. In the following section, we will see how these concepts can be translated into models of behavior.

## **2 Theoretical approaches of the role of social norms**

Several disciplines have integrated social norms in their models of behavior. In this section, we will describe how social norms have been integrated in social psychology and in economics. We will mainly focus on approaches that have been developed to predict and explain pro-environmental behavior. Finally we propose a model that explains the role of injunctive and descriptive norms in the adoption of AES.

### **2.1 Social norms in social psychology**

The TPB presented in chapter 1, which is one of the prominent models of behavior in social-psychology, does include social norm among the main predictors of behavior. We remind that TPB considers three independent predictors of intention: the attitude toward the behavior”, the perceived behavior control and the subjective norm. The subjective norm is the social

norm component of the TPB. It represents the “perceived social pressure to perform or not to perform the behavior.

The TPB has been used to analyze a wide array of behavior, which has however revealed that subjective norm plays a limited role as compared to the other 2 predictors of behavior: attitude and perceived behavior control. For example, in a meta-analysis, Armitage and Conner (2001) find that the average influence of attitude is twice as large as the one of subjective norm. Since then, several authors including Ajzen have supported the inclusion of the other dimensions of normative influence such as the inclusion of personal norm and descriptive norms. Research has demonstrated that both these norms have an independent influence on intentions in addition to the influence of other TPB predictors (White *et al.*, 2009). Ajzen and Fishbein (2005) have therefore recommended the incorporation of descriptive norm in the TPB constructs. Recently, several investigators have included descriptive norms as predictors of intentions in the planned behavior model. Ravis and Sheeran (2003) conducted a meta-analysis of descriptive norm in the planned behavior context. Their analysis, based on 18 studies, demonstrate a significant relationship between descriptive norm and intention to perform a behavior. Manning (2009) even finds evidence of a direct influence of the descriptive norm on behavior in the context of the TPB. Thøgersen (2014) emphasizes that the importance of perceived norms in pro-environmental behavior may be underestimated due to i) correlations between injunctive and descriptive norms, the fact that the influence of injunctive norms is (at least partly) mediated through personal norms and iii) the influence of descriptive norms on behavioral intentions is (at least partly) mediated through self-efficacy and through the attitude towards the behavior.

## **2.2 Norms in economic models**

Norms have recently been included in a number of micro-economic models. Six articles have particularly raised our attention due to their explicit focus on the incorporation of social norms and/or personal norms. We organize these articles according to the way norms have been modeled.

Three articles focus on considering that social norms generate a feeling of **social approval or disapproval** that is taken into account in the utility function of agents.

Lindbeck *et al.* (1999) analyze the impact of social norm in the context of a State that provides welfare benefits to unemployed people. In this model, people are considered to be subject to a social norm of not living off other people's work, experienced as a feeling of disapproval.

However, the effect of this disapproval is considered to decrease with the amount of unemployed people. According to the social norm literature, this model considers that there is an injunctive proscriptive norm of not living of social welfare but that the effect of this social norm decreases with number of people that infringe it (the descriptive norm). This formulation is close to Bicchieri's model of social norm (Figure 5) although it does not consider the issue of perception of the norms.

Rege (2004) proposes a public good model that integrates the fact that contributing or not exposes you to approval or disapproval from those who contribute. In this 2 step game, people chose to contribute or not to the public good and in the second step meet other players. If a player does not contribute and meets another player who contributed in the first step, he feels disapproval. On the contrary a contributor feels approval if he meets another contributor. The model also considers a parameter of social viscosity that reflects the fact that players have more odds to meet a person with the same behavior as theirs. This article uses evolutionary game theory to determine how people converge to the equilibria of this game.

Blasch and Ohndorf (2015) develop a theoretical model that is based on the same modeling approach as Rege to which they add a subjective estimation of the contributors rate and the feeling of pure and impure altruism provoked by the contribution to a public good. Their hypothesis is that all these factors affect the willingness to participate in an offsetting scheme. These hypotheses are confirmed in a large scale choice modeling carried out in Germany and the United States.

Fischer and Huddart (2008) consider a slightly different approach in which **personal and social norms modulate the cost of carrying out an action**. The social norm effect is not an additive term but rather a term of the cost function. They develop a Principal-Agent model, in which agents of a firm chose to adopt a certain level of desirable action. The cost of the agents' action is directly linked to their level of effort but is also linked to the effect of norms. The cost of implementing a desirable action diminishes with their personal norm relative to "hard work" as well as by the average level of action of the other members of the firm: the descriptive norm. In presence of such a norm for desirable action, this induces a multiplier effect of monetary incentives: it increases the amount of desirable action that increases the social norm that in turn increases the level of desirable action. The authors however also acknowledge that norms for carrying out undesirable activities exist in firms (such as concealing financial information), and that agents may be more inclined to carry out such an

undesirable activity when more people adopt it. This type of norm plays in the exact opposite direction than the other one.

Nyborg et al. (2006) propose a model that is inspired by the norm-activation theory of Schwartz (1977; 1978) that considers the impact of the **feeling of responsibility** to carry out a pro-environmental behavior. According to Nyborg *et al.*, individuals feel responsible to carry out the behavior if they consider others take this responsibility, a sort of “socially contingent moral motivation”. In other words, individuals perceive a responsibility payoff that increases with the percentage of adoption of this behavior in the population. The model therefore mixes different notions of norms such as personal norms and descriptive norms. They apply this approach to a public good game. Adding this responsibility payoff to the traditional public good game turns it into a coordination game (if personal norms are strong enough) that has 3 types of equilibria: i) one in which no one adopts the pro-environmental behavior ii) one in which everybody adopts, and finally iii) one in which the responsibility payoff exactly compensates the difference between the cost of contributing to the public good and the private benefit of the public good. The model is subsequently used to test how policy instruments can ensure the transition from one equilibrium to another using the same evolutionary game theory tools as in Rege (2004).

Benabou and Tirole (2012) propose a very different approach, based on a **social signaling model, that puts together the feeling of distinctness and conformity**. Agents are characterized by a level of intrinsic motivation to carry out a pro-social activity, a personal norm. They are also submitted to a reputational payoff that reflects the judgement of others as they assess intrinsic motivations, which is private information, in light of the agents’ actions. The relative importance of the feeling of distinctness and conformity depends on the distribution of intrinsic preferences. If few people adopt the virtuous behavior, a heroic action such as saving ones’ life risking your own, only those with strong intrinsic motivations will undertake it and will receive a great honor for doing so. On the contrary, if almost everybody adopts the behavior, a norm like “not killing people”, will require very limited intrinsic motivations and deviations from this norm will provoke a strong stigma. Interestingly, for the first case, an increased adoption of the pro-social behavior will reduce social rewards (substitutability) while for the second case an increased adoption will strengthen social rewards (complementarity).

Despite their different entry points, these models generally consider the impact of others' action on individual decision, which is a certain form of descriptive norm, except the Benabou and Tirole (2012). Even in the models that rather deal with the injunctive norm, the level of participation of others is the key variable: in Rege (2004), the injunctive norm is directly linked to the number of contributors that people meet and in Lindeck et al (1999) there is an assumption that the strength of the injunctive norm decrease with the number of people who do not respect it. Considering that injunctive norms are supposed to be what people think "ought to be done", there should be an effort to model this particularity. There is very little information in the literature that gives hints on how the opinions on what should be done are formed and therefore how they could be modeled.

One other important aspect of norm that is not well captured in the models is their subjective nature; people have a perception of norms that may be different from the reality. This perception can deviate especially when actions are not salient or when actions are not taken regularly and people need to make assumptions about what will be the decision of others when it's time to take the decision. The example of agri-environmental contracts that are periodically signed each year is a good example of this type of behavior. The only article that takes into account this particularity is in Blasch and Ohndorf (2015).

Three models out of the seven use evolutionary-game theory to predict the stability of equilibria and the dynamic of evolution from one equilibrium to the other. The other models are static models. This is a weakness as the main interest of normative policy interventions is the evolution of norms and how they can affect behavior change.

Finally models consider that the descriptive norm strengthens pro-social behavior. They do not consider the fact that in the early stages of adoption of a pro-social activity, the descriptive norm may actually be not to adopt this pro-social behavior and that this may hinder the general adoption of this behavior.

## 2.3 Modelling the effect of descriptive and injunctive norms on the adoption of AES: our proposal

This section presents an attempt to model farmers' enrolment in AES in the presence of an injunctive and a descriptive norm. It intends to understand how economic predictions are modified when these behavioral factors are introduced. This model provides a framework to understand better observed rates of AES uptake.

### 2.3.1 Basic framework

This theoretical framework is close to the one proposed by Rege (2004). We consider a continuum  $[0,1]$  of identical farmers. Each farmer  $i \in [0,1]$  has to decide either to participate in an agri-environmental scheme AES ( $e_i = 1$ ) or not ( $e_i = 0$ ). Enrolment in AES corresponds to a contribution of a fixed amount,  $e_i = 1$ , to a public good that benefits the whole society.

Let  $x$  denote the share of enrolled farmers in AES,  $x \in [0,1]$ . Since there is a continuum of farmers, we consider that a farmer  $i$ 's enrolment has no effect on the average provision of public good,  $\bar{e} = x$ .

To represent farmer  $i$ 's preferences without taking into account the influence of social norms, we use the simplest specification:

$$U_i = (p - c)e_i + \beta \bar{e}$$

with  $c$  the cost to enrol in AES,  $p$  the AES payment and  $\beta$  the farmer's private benefit derived from the average provision of the public good,  $\bar{e}$ .

The difference in farmer  $i$ 's utility between enrolling and not enrolling in AES is given by:

$$\Delta U = U_i^1 - U_i^0 = p - c$$

Farmers enrol in AES only if  $\Delta U > 0$ .

**Result 1:** *Without social norms, farmers enrol in AES if and only if  $p > c$ .*

### 2.3.2 Descriptive norm

We propose to specify the utility gains or losses associated with the conformity to the social descriptive norm  $u_{DN}$  with the following specification:

$$u_{DN} = (2e_i - 1)(2x - 1)$$

This specification reflects the fact that individuals perceive a utility (disutility) when they conform (do not conform) to the descriptive norm. As shown in Figure 6, if the farmer does not enrol in AES ( $e_i = 0$ ), he gets a positive utility from acting like all other farmers if  $x = 0$  but his utility decreases as  $x$  increases and becomes negative when the majority of farmers enrolls in AES, i.e. when  $x > \frac{1}{2}$ .

If the farmer enrolls in AES ( $e_i = 1$ ), his utility from not conforming to the descriptive norm is negative when  $x = 0$ , but increases with  $x$  and becomes positive as soon as the majority of farmers acts like him, i.e.  $x > \frac{1}{2}$ .

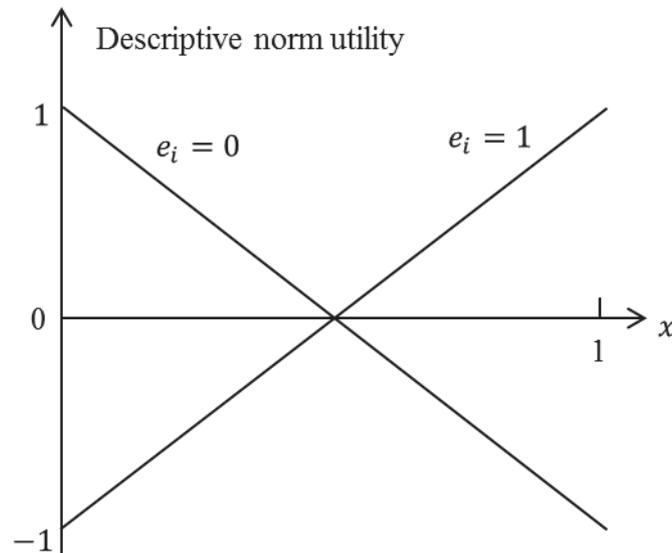


Figure 6: Variation of descriptive norm utility according to participation

This specification entails that the descriptive norm is not only exerted by people who adopt a pro-social behavior but also by people who don't. This novel approach intends to reflect the observed resistance of farmers to participate in pro-environmental policies.

With this descriptive norm specification, farmer  $i$ 's utility is:

$$U_i = (p - c)e_i + \beta\bar{e} + \lambda(2e_i - 1)(2x - 1)$$

$$\Delta U = p - c + 2\lambda(2x - 1)$$

with  $\lambda$  a scale parameter reflecting the weight of the descriptive norm in the utility function of farmers. This weight can be either seen as a susceptibility to the descriptive norm or its salience.

As in Rege (2004), let  $x'$  be defined by  $\Delta U = 0$ ,  $x' = \frac{1}{2} - \frac{p-c}{4\lambda}$

**Result 2:**

- *The game has a Nash equilibrium in which every farmer enrolls in AES if and only if  $p \geq c - 2\lambda$ .*
- *The game has a Nash equilibrium in which no farmer enrolls in AES if and only if  $p \leq c + 2\lambda$ .*
- *The game has a Nash equilibrium in which a share  $x'$  of farmers enrol in AES if and only if  $c - 2\lambda < p < c + 2\lambda$ .*

*Proof:*  $\Delta U = 0$  if and only if  $x = x'$ . Note that  $\Delta U$  is an increasing function of  $x$ . Thus  $\Delta U \geq 0$  if and only if  $x \geq x'$  and  $\Delta U \leq 0$  if and only if  $x \leq x'$ .

Furthermore, note that  $x' \leq 1$  if and only if  $p \geq c - 2\lambda$ . If  $x = 1$ , farmer  $i$  choosing  $e_i = 1$  will not deviate unilaterally from his choice because  $\Delta U \geq 0$ . Thus,  $e_i = 1$  for all  $i$  is a Nash equilibrium (NE  $e=1$ ) if and only if  $p \geq c - 2\lambda$

In the same way, note that  $x' \geq 0$  if and only if  $p \leq c + 2\lambda$ . If  $x = 0$ , farmer  $i$  choosing  $e_i = 0$  will not deviate unilaterally because  $\Delta U \leq 0$ . Thus  $e_i = 0$  for all  $i$  is a Nash equilibrium (NE  $e=0$ ) if and only if  $p \leq c + 2\lambda$ ,

$e_i = 1$  for a share  $x'$  of farmers enrolling in AES is also a Nash equilibrium (NE  $e=x'$ ) if and only if  $c - 2\lambda \leq p \leq c + 2\lambda$ .

Figure 7 presents the conditions on  $p$  for the existence of the Nash Equilibrium.

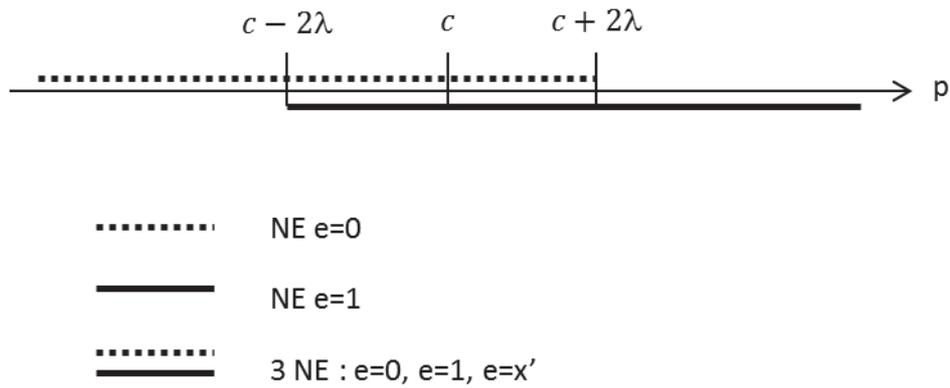


Figure 7: Nash equilibria with the descriptive norm in relation with the value of p

*Corollary:*  $p > c$  is no longer a sufficient condition for every farmer to enrol in AES (when enrolment rate is low), nor  $p < c$  a sufficient condition for farmer not to enrol in AES (when enrolment rate is high).

$p > c + 2\lambda$  is a necessary and sufficient condition to have a single Nash equilibrium in which all farmers enrol in AES.

$p < c - 2\lambda$  is a necessary and sufficient condition to have a single Nash equilibrium in which no farmer enrolls in AES.

Result 2 implies that when we include descriptive norms in the model, we obtain a coordination game if  $c - 2\lambda < p < c + 2\lambda$ . In this case, the game has three Nash equilibria; one in which every farmer enrolls in AES, one in which no farmer enrolls and one in which a share  $x'$  enrol in AES.

However, the game has only two asymptotically stable states ( $x = 0$  and  $x = 1$ ). Indeed, the mixed Nash equilibrium is not an asymptotically stable state in an evolutionary game setting. Following Rege (2014), we use the replicator dynamics to represent a “virtual” learning process of trial-and error.

*“The replicator dynamics say that the growth rate of the population share using a certain strategy equals the difference between the strategy’s current payoff and the current average payoff in the population (Weibull, 1995, p. 73).”*

In our case, the replicator dynamics is given by:

$$\dot{x}(x) = x(U_i^1(x) - \bar{U}(x))$$

Where  $\bar{U}(x) = xU_i^1(x) + (1 - x)U_i^0(x)$

$$\dot{x}(x) = x(1 - x)\Delta U(x)$$

$$\dot{x}(x) = x(1 - x)[p - c + 2\lambda(2x - 1)]$$

Stationary states are determined by  $\dot{x}(x) = 0$ . Thus, there are three stationary states:  $x = 0$ ,  $x = 1$  and  $x = x' = \frac{1}{2} - \frac{p-c}{4\lambda}$ .

For  $0 < x < 1$ ,  $\dot{x} > 0$  if  $\Delta U = p - c + 2\lambda(2x - 1) > 0$  and thus if and only if  $x > \frac{1}{2} - \frac{p-c}{4\lambda} = x'$ . Symmetrically, for  $0 < x < 1$ ,  $\dot{x} < 0$  if  $\Delta U = p - c + 2\lambda(2x - 1) < 0$  and thus if and only if  $x < \frac{1}{2} - \frac{p-c}{4\lambda} = x'$ . Hence,  $x = x'$  is not an asymptotically stable state because if the share of farmers who enrol in AES moves above  $\max\{0, x'\}$ , then  $x > x'$  and  $\Delta U > 0$ . Therefore more farmers will enrol in AES. This process will continue until all farmers are enrolled and the asymptotically stable state  $x = 1$  is reached. Symmetrically, if the share of farmers who enrol in AES moves below  $\min\{1, x'\}$ , then more farmers will quit the AES. This process will continue until all farmers leave the AES and the asymptotically stable state  $x = 0$  is reached.

This model illustrates that the descriptive norm can be an obstacle in the early phases of implementation of an AES programme. In the conditions where the three equilibria are possible ( $c - 2\lambda < p < c + 2\lambda$ ), unless participation reaches a minimum threshold ( $x'$ ), the descriptive norm is a factor that induce farmers not to enrol. Only when a minimum level of participation is reached ( $x'$ ) does the descriptive norm reinforce farmers' enrolment rate.

### **2.3.3 Injunctive norm**

Two features characterize the injunctive norm we want to model. First, we assume that the injunctive norm to enrol in AES comes from the whole society: farmers but also and mainly from non-farmers. This specification is an innovation as injunctive norms are generally considered to be exerted by peers. However, the TPB survey revealed that people who seem to have an influential opinion are not neighbour farmers but rather other members of the society such as spouses and technicians. Second, we assume that the injunctive norm is exerted more strongly when the level of the environmental public good  $\bar{e}$  is low. Indeed, when no farmer is enrolled in AES, the level of the environmental public good is at its lowest level. It is usually when the society strongly urges farmers to change their practices. However, as

the state of the environment improves, i.e. the provision of public good increases, the injunction to enrol in AES weakens.

Assume that conforming to the injunctive norm yields the following (dis)utility  $u_{IN}$ , which takes the following specification:

$$u_{IN} = \frac{2e_i - 1}{\bar{e} + 1} = \frac{2e_i - 1}{x + 1}$$

This specification reflects the fact that farmers perceive a utility (disutility) when they conform (do not conform) to the injunctive norm which decreases as  $x$  increases. If the farmer does not enrol in AES ( $e_i = 0$ ), he feels social disapproval. Disapproval decreases as the enrolment rate (and therefore the provision of public good) increases. Alternatively, if the farmer enrolls when no-one else does so, he feels social approval ( $e_i = 1$ ). However social approval decreases as  $x$  increases (Figure 8).

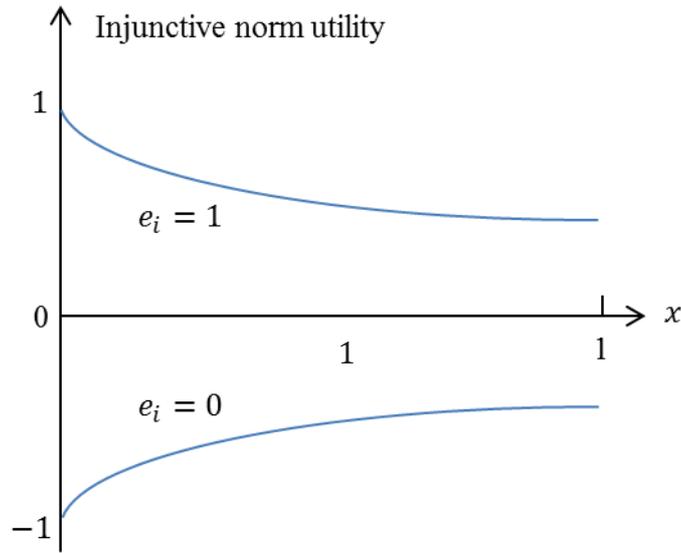


Figure 8: Variation of injunctive norm utility according to participation

With this injunctive norm specification, farmer  $i$ 's utility is:

$$U_i = (p - c)e_i + \beta\bar{e} + \sigma \frac{2e_i - 1}{x + 1}$$

with  $\sigma$  a scale parameter for the injunctive norm reflecting the weight of the injunctive norm into the total utility. This weight can be either seen as a susceptibility to the injunctive norm or its salience.

$$\Delta U = p - c + \frac{2\sigma}{x+1}$$

Let  $x'$  be defined by  $\Delta U = 0$ .

**Result 3:**

- The game has a Nash equilibrium in which every farmer enrolls in AES if and only if  $p \geq c - \sigma$ .
- The game has a Nash equilibrium in which no farmer enrolls in AES if and only if  $p \leq c - 2\sigma$ .
- The game has a Nash equilibrium in which a share  $x'$  of farmers enrol in AES if and only if  $c - 2\sigma < p < c - \sigma$ .

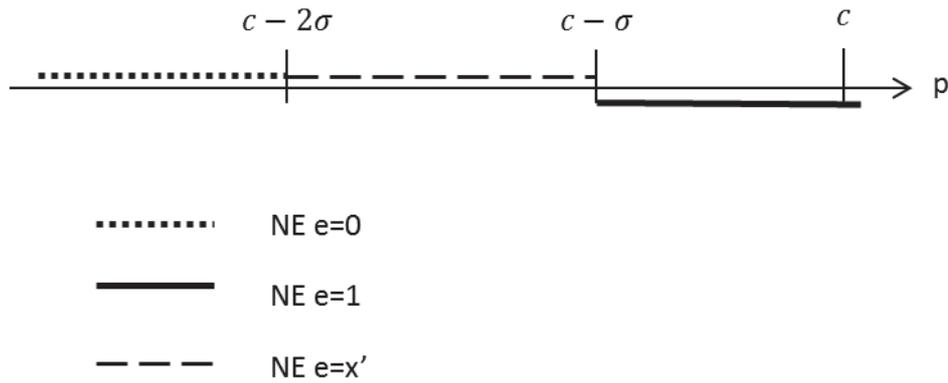


Figure 9: Nash equilibria with the injunctive norm in relation with the value of  $p$

*Proof:* First note that  $\Delta U$  is monotonously decreasing in  $x$  on  $[0,1]$ . Thus,  $e_i = 1$  for all  $i$  is a Nash equilibrium if and only if  $\Delta U > 0$  when  $x = 1$ , i.e. if and only if  $p > c - \sigma$ . Then,  $e_i = 0$  for all  $i$  is a Nash equilibrium if and only if  $\Delta U < 0$  when  $x = 0$ , i.e. if and only if  $p < c - 2\sigma$ . Finally,  $e_i = 1$  for a share  $x' = \frac{2\sigma}{p-c} - 1$  of farmers enrol in AES if and only if  $c - 2\sigma \leq p \leq c - \sigma$ .

*Corollary:* As defined here, the injunctive norm shall only have a positive impact on enrolment.  $p < c$  is no longer a sufficient condition for farmers not to enrol in AES as the injunctive norm effect (social approval vs social disapproval) may compensate a payment which might be lower than the cost of enrolment.

Contrary to Result 2 for the model with the descriptive norm, Result 3 shows that the game is not a coordination game. Indeed, the necessary and sufficient conditions for each Nash equilibrium do not overlap with each other (Figure 9). Thus we do not need to refer to an evolutionary analysis to confirm that the three Nash equilibria are the three asymptotically stable states of this game.

Contrary to the descriptive norm, the injunctive norm is a driving force for the adoption when few farmers participate. However, when AES uptake increases, the positive influence of the injunctive norm to participate is decreasing.

### 2.3.4 Combination of descriptive and injunctive norms

Combining descriptive and injunctive norms in farmer  $i$ 's utility gives:

$$U_i = (p - c)e_i + \beta\bar{e} + \lambda(2e_i - 1)(2x - 1) + \sigma \frac{2e_i - 1}{x + 1}$$

$$\Delta U = p - c + 2\lambda(2x - 1) + \frac{2\sigma}{x + 1}$$

Consequently:

$$\frac{d\Delta U}{dx} = 0 \text{ if } x = \hat{x} = \sqrt{\frac{\sigma}{2\lambda}} - 1$$

$\Delta U$  is decreasing if and only if  $x < \hat{x}$  and  $\Delta U$  is increasing if and only if  $x > \hat{x}$

Let  $\Delta U_{min}$  be  $\Delta U$  when  $x = \hat{x}$ .

This more complex specification leads to different cases depending whether:

- $\hat{x} \leq 0$  (case 1), if and only if  $\sigma \leq 2\lambda$
- $0 < \hat{x} < 1$  (case 2) if and only if  $2\lambda < \sigma < 8\lambda$  or
- $\hat{x} \geq 1$  (case 3) if and only if  $\sigma \geq 8\lambda$ .

Falling into one case or another therefore only depends on the relative weight that farmers grant to descriptive norm ( $\lambda$ ) and subjective norm ( $\sigma$ ). Each of these three cases has three or five subcases (see Appendix 2 for a description of each subcases).

One interesting case is the case 2 in which  $\lambda$  and  $\sigma$  are relatively similar. The subcase 2b is particularly challenging because it presents three Nash equilibria: two in which only a share

of the population enrolls in the AES ( $x'$  and  $x''$ ) and one in which everybody enrolls. However there are only two asymptotically stable states in this coordination game:  $x = x'$  and  $x = 1$ . This case is presented in Figure 10.

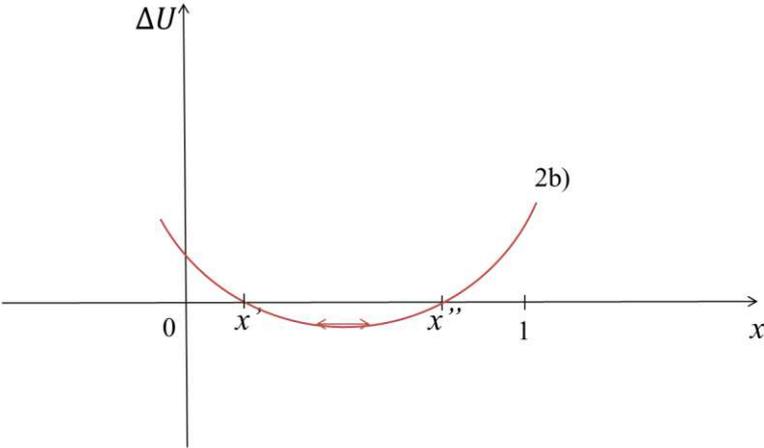


Figure 10: Presentation of the variation of utility between participating or not, according to participation, in the presence of injunctive and descriptive norms (Case 2b)

A first level of participation  $x'$  can be attained mainly thanks to the effect of the injunctive norm. However, beyond that point, only if the participation rate reaches a level superior to  $x''$  can the descriptive norm guarantee a significant improvement in enrolment.

This subcase could well describe the situation observed in many areas where AES have been introduced. The adoption rate of AES still remains quite limited. Thanks to payment and the effect of injunctive norms, the first equilibrium may be attained. However the descriptive norm still influences negatively adoption and does not allow to significantly improve participation to AES.

### **3 Empirical analysis of the effect of social norms on AES adoption**

The objective of this empirical section is to analyze the effect of social norms on the adoption of agri-environmental schemes. We first describe the different methodologies that have been used to evaluate this effect, then the existing empirical evidence on the impact of social norms on the adoption of pro-environmental practices and agri-environmental schemes and finally we present the our empirical study.

#### **3.1 How to measure the effect of social norms on the adoption of AES?**

Among the methods used to analyze the impact of social norms, we can distinguish different categories. The effect of social norm can be either analyzed through revealed preferences or through stated preferences methods. Among revealed preference methodologies, it is possible to use standard non-experimental data sets or to generate experimental or quasi-experimental data. We will first highlight issues related to standard revealed preferences methodologies and of stated preference methodologies and then we describe some of the experimental methodologies that have been used to evaluate the effect of social norms.

##### ***3.1.1 Stated and revealed preference methodologies***

Manski (2000) argues that there are different reasons why people of the same group may behave in the same way and that only one of these can be considered a social norm. This creates difficulties for the identification of the role of social norm in standard revealed preference methods. He identifies three hypotheses that may explain that members of the same group may have the same behavior: 1) *endogenous interactions*, wherein the propensity of agent to behave depends on the behavior of the group, i.e. social norm interaction, 2) *contextual interactions* wherein the behavior is influenced by exogenous characteristics of the group members and 3) *correlated effects* wherein agents of the same group tend to behave similarly because they have similar individual characteristics or face similar institutions. Farmers may adopt a similar behavior for one of these reasons. Endogenous interactions may intervene and, all other things equal, farmers' practices may change along with the practices of other farmers of their reference group, due to the effect of social norms. However, farmers' practices of a group may change simultaneously because of shared individual characteristics such as farm size or economic situation (contextual interaction). Finally, there may be

correlated effects and farmers of the same group may all adopt pro-environmental practices because they depend from the same cooperative or be technically assisted by the same technician.

Other type of difficulties may occur with stated -preferences studies because people tend to underestimate the power of social norms. Nolan et al (2008) compare the influence of the stated importance of social norms with the influence of beliefs on the social norm on individuals' decision to have a pro-environmental behavior. People consider that saving energy because "other people are doing it" is the least important reason as compared to "protecting the environment", "providing benefits to the society" or "saving money". However when looking at their beliefs on the influence of energy saving on environment protection, saving money, society benefits and their beliefs on what other people do, the belief that is the most correlated with energy saving behavior is the one about what others do. In an experimental study, they also test the effect of different types of motivational messages on energy consumption. They confirm that the normative message is the most influential (as compared to appeals for protecting the environment or even for saving money) however, when asked whether they considered these messages as influential, the normative message was considered the least motivating. Cialdini (2007) also insists on the fact that people ignore or largely underestimate the effect of others' action on their own behavior.

Estimating empirically the influence of social norms is one of the key challenges of our research. The key assumption, which determines the estimation methodology, is the importance given to the subjective nature of norms. Bicchieri (2006) insists on the fact that people form expectations or beliefs about others' opinion and behavior and it is rather these beliefs which affect behavior, more than actual behavior and opinions of others. Considering beliefs is particularly important when the opinion and behavior of others cannot be easily observed. If we consider that this particularity of norms can be neglected, it is possible to use proxies and existing databases providing information on the behavior of others and possibly on their opinion. This allows the use of existing databases, not specifically collected for the purpose of analyzing social norms. On the contrary, if we consider subjective expectations on social norms to be fundamental, the use of specifically designed stated-preference surveys is required. An other important point is that finding proxies for injunctive norms is problematic in existing databases that have not been designed for this question. Authors that have done this have used indirect indicators such as for example voting decisions on a similar question

(Stutzer and Lalive, 2004). Table 12 considers different methodologies that could be used to estimate social norms depending on the importance of beliefs and expectations.

Assumptions	Descriptive norm	Injunctive norm
Opinions and decisions of others are easily observable. Estimating farmers' beliefs is not crucial. <b>Revealed preference methodologies</b>	<b>Examples of articles using this type of approach:</b> Abbott <i>et al.</i> , 2013; Munshi and Myaux, 2006 <b>Possible indicator:</b> adoption of AESs in the considered area in the previous contracting period. <b>Data availability:</b> National databases on AES adoption	<b>Examples of articles using this approach:</b> Stutzer and Lalive, 2004 <b>Possible indicator:</b> Votes for the green party in the European parliament in the considered area (proxy) <b>Data availability:</b> National database of elections at the municipality level.
Opinions and decisions of others are not easily observable. Beliefs must be measured to estimate the role of social norms. <b>Stated-preferences methodologies</b>	<b>Examples of articles using this approach:</b> Thøgersen, 2006; Croson <i>et al.</i> , 2009 <b>Possible indicator:</b> subjective expectations on the adoption of AES in the considered area. <b>Data availability:</b> requires a specific survey.	<b>Examples of articles using this approach:</b> Thøgersen, 2006; Fielding <i>et al.</i> , 2005; Beedell and Rehman, 1999 <b>Possible indicator:</b> What is the opinion of important others on my adoption of AES? <b>Data availability:</b> requires a specific survey

Table 12: Possible indicators of the role of social norms on the adoption of AES depending the importance given to the role of expectations and beliefs on social norms.

The importance of beliefs in social norms regarding the adoption of AES can be discussed. Decisions of other farmers on the adoption of AES (descriptive norm) should be easily observable by farmers and therefore analyzing beliefs should not be crucial. Beliefs could however be important when adoption decisions are taken simultaneously by farmers or when farmers make anticipation on the future behavior of others. The perception of the opinion of others, the injunctive norm, is however clearly highly subjective.

The main limitation of the stated and revealed preference methods described above is the presence of several confounding factors that make the identification of causality link very difficult.

### **3.1.2 Experimental methodologies**

In order to identify more robust causality links, experiments have been used to test the effect of social norms. If we consider only field experiments, different methodologies have been used throughout the literature. The common characteristic of these experiments is to identify a sample and in this sample to randomly choose a group to which a treatment is applied and a control group that receive no treatment. After the treatment is applied, the effect on a predetermined output variable is determined. The advantage of this methodology is that if membership in the group is chosen randomly all members of the group are statistically similar and the difference is only due to the effect of the treatment. The experimental methodologies that have been used differ on the treatment applied and on the output variable.

Two types of nudges associated with social norms have been widely used: information on the behavior of others and the salience of norms. One important type of nudge is the provision information on the behavior of others. One example is the famous experiment that analyzes the impact of providing information on the energy use of other household on individual household consumption (Allcott, 2011). Another quite large number of experiments provide information on the contribution to public good of others (charity, public radio) and monitor the impact on individual contributions (Frey and Meier, 2004; Croson and Shang, 2008; Alpizar *et al.*, 2008; Shang and Croson, 2009).

Others have rather tested the effect of making descriptive norm or injunctive norms salient using different type of action or communication messages. These interventions are grounded in the theory of normative conduct of Cialdini et al. (1990). For example, Cialdini et al. (1990) make the anti-littering injunctive norm salient by putting anti-littering signs while they make the descriptive norm salient by both manipulating the descriptive norm (clean or littered environment) and showing to subjects a confederate experimenter that litters (focusing device).

In most of these experiments, the output variable is the actual people's behavior however in some instances, experimental or quasi-experimental procedures can be used to analyze the impact on stated preferences. Two examples of such approach will be described in the empirical evidence on the role of social norms on the adoption of agri-environmental contracts or pro-environmental practices (Chen *et al.*, 2009; Kuhfuss *et al.*, 2016).

The main constraint of experimental methodologies in the field is their feasibility. They require a conjunction of conditions for the implementation of a nudge and the observation of the output that are not easy to obtain in farming conditions. To our knowledge, no field experiment involving the implementation of a nudge and an analysis of its impact on actual farmers' decision has been implemented so far.

### **3.2 Empirical evidence of the role of social norms on pro-environmental behavior in agriculture**

Examples of the influence of social norms in prosocial behavior and in particular in the adoption of pro-environmental behavior are manifold (Farrow, 2016 for a review). However evidence of the role of social norms in the adoption of pro-environmental practices by farmers is relatively scarce and even less so for the adoption of agri-environmental schemes.

Willy and Holm-Müller (2013) analyze the impact of social influence on the adoption of soil erosion techniques by farmers in Kenya. They highlight that the perceived subjective norm as well as the descriptive norm, quantified by the level of adoption of soil erosion techniques at the village level, have a positive influence on the number of soil erosion techniques adopted by Kenyan farmers. On the contrary, Wauters *et al.* (2010) apply the TPB to understand factors affecting the adoption of soil erosion techniques in Belgium and find no significant effect for the role of the subjective norm.

Fielding *et al.* (2005) study the intention of farmers to adopt riparian zone management practices. The perception of support by other people/institutions and the willingness to follow other groups' opinion is one of the variables that characterize farmers who have the intention to adopt pro-environmental practices. Beedel and Rehman (1999) establishes that farmers who adopt sustainable hedge management practices feel greater social pressure to do it.

Two studies have analysed the role of social norms on the adoption of AES. Defrancesco *et al.* (2008) study the influence of numerous socio-economic factors as well as behavioral factors on the adoption of AES. They find *inter alia* that farmers who perceive that other farmers have a positive opinion on AES are more likely to adopt a contract. Allaire *et al.* (2009) use spatial econometrics in order to estimate the influence of neighbour effect in the adoption of AES. They find effects of spatial proximity at the municipality and the micro-zone level that they attribute to the effect of social networks. Although the authors do not

consider this hypothesis, this effect may also be caused by the presence of a descriptive norm at these levels.

To our knowledge, two studies, which use either an experimental approach or a choice experiment, exist on the role of social norms on the adoption of agri-environmental contracts. In the context of a PES scheme subsidising farmers for reforestation in China, Chen *et al.* (2009) show, through a choice experiment survey, that individual intentions to re-enrol is positively influenced by the information that neighbours also intend to re-enrol, i.e. the descriptive norm. Farmers also stated that they would require lower subsidies to carry out environment protection activities if a large proportion of farmers re-enrol than if few farmers would do so (Chen *et al.*, 2009).

We also participated in an experiment in which we quantify the impact of providing information on other farmers' behavior on the intention to maintain pro-environmental practices after the end of commitment of an AES (Kuhfuss *et al.*, 2016). In a survey carried out with 395 farmers, farmers were asked whether they intended to maintain their pro-environmental practices at the term of their agri-environmental contract. The experiment consisted in providing different information on the behavior of other farmers. In the control treatment (128 respondents), farmers were not provided information. In treatment 1 (121 respondents), farmers were informed that in a previous survey 80% of the respondents stated that they would maintain the new practices they had adopted during the AES, even without a new contract. Treatment 2 (141 respondents) was a different framing of the same information, "20% of the respondents stated that they would not maintain the new practices". 61% of farmers who received the information declared that they will maintain their agricultural practices while 43% of farmers in the control treatment. This difference is highly significant. We mainly attributed this to the effect of the descriptive norm on individual decision to maintain agricultural practices at the end of their contractual commitment.

### **3.3 A stated-preference survey on the role of social norms in the adoption of pro-environmental practices**

Considering the importance of the subjective estimation of social norms, the fact that finding valid proxies of the injunctive norm did not seem doable and the fact that running a field experiment did not appear to be feasible in this PhD, we decided to run a stated-preference survey. The idea was to expand the TPB survey described in chapter 1 to a wider sample of farmers with a simplified version of the questionnaire.

### **3.3.1 Survey methodology**

Several challenges need to be addressed in stated-preference surveys in order to detect a causality link between explanatory variables (especially the social norm indicators) and the participation to AES, among which endogeneity and self-selection.

The main endogeneity problem comes from the fact that once farmers have enrolled in AES, they may change their characteristics/statement due to the fact that they adopted. For example their perception of environmental issues or their socio-economic characteristics may be changed by their participation to the AES. If we statistically observe a difference between participants and non-participants, it may actually be the result of their participation and not its cause. In order to mitigate that problem, we used the opportunity of the discontinuity provoked by the CAP reform. In June 2015, all AES contracts ended and farmers had to decide whether to sign or not a new AES contract. Our survey was carried out exactly in this period. The endogeneity effect was therefore *a priori* limited by this precaution.

The self-selection bias, *i.e.* the fact that the characteristics of the voluntary participants in AES differ from the ones of the non-participants is not an issue in this type of analysis. Indeed, self-selection is actually the object of our analysis. What we want to determine is the difference in terms of characteristics and statement between the ones who participated in the AES and the ones who did not. There is however a self-selection bias related to the voluntary participation to this survey. In this study, we indeed assume that the characteristics of the people who participate are representative of the characteristics of the farmers in Languedoc Roussillon.

The questionnaire was sent to 700 vine-growers of the Languedoc Roussillon region in the South of France located in areas where AES aimed at the protection of water quality are proposed to farmers. The sample was focused on this type of farmer in order to limit the heterogeneity and because wine production represents one of the main present environmental challenges, the impact of pesticide in wine production on water quality. The invitation to participate in the survey was sent by facilitators who are involved in the implementation of AES aimed at improving water quality at the territorial level. 101 farmers responded to the questionnaire of which 3 responses were eliminated because farmers were not eligible to the proposed AES. 98 exploitable answers are therefore analyzed in this survey. In this sample, 56 farmers declare to have signed an AES in 2015. To this sample we will add, the response of the 51 farmers that responded in the TPB survey.

The questionnaire of this study was based on the TPB survey. The idea was to keep the main socio-economic characteristics, the general indicator of the TPB (Attitude, Control) and the norm indicators that help responding to the issues raised in the literature review. We especially dropped all questions related to the estimation of beliefs that made the TPB questionnaire particularly complicated.

The behavior we try to estimate is the decision to participate in an AES. Two different questions were asked to analyze this behavior:

*“Have you decided to sign an AES in 2015?” (Yes/No)*

and for those who responded “No” to this question:

*“Do you have the intention to sign an AES in the two following years (2016, 2017)?”*

The idea of adding this second question was that some farmers may not have signed the contract but may still have an intention to do it and may have been limited by exogenous factors such as budget limitation for the implementation of the policy. Adding this question helps having a more refined characterization of their behavior.

The descriptive norm was characterized by a question that evaluated the perception of the frequency of the considered behavior among our target population:

*“According to you, what percentage of farmers of your territory will sign an AES in 2015?”*

We kept the notion of “territory” vague so that farmers could decide themselves what is their territory of reference. It was not possible to specify more precisely this notion considering the heterogeneity of what farmers consider as their community of reference (municipality, watershed, cooperative...).

The injunctive norm was evaluated using two statements on which farmers were asked to indicate their level of agreement. One referred to the injunctive norm amongst other farmers of the territory:

*“The majority of farmers of my territory are in favor of AES.”*

The other one referred to the injunctive norm amongst important other people (Cf. subjective norm in the TPB (Ajzen, 1991):

*“People who are important to me think I should sign an AES.”*

Considering that injunctive norm may also impact decision through reputation (Benabou and Tirole, 2012), we also characterized the perception of the reputational dimension of signing an AES by asking:

*“How do the other farmers of the territory perceive a farmer who signs an AES?”* (Very negatively, negatively, neither negatively nor positively, positively, very positively)

The questionnaire included also a statement related to the personal norm of farmers based on the formulation recommended by Schwartz (1977):

*“I feel a moral obligation to modify my agricultural practices in order to improve the quality of water.”*

To these questions, we added two predictors of the TPB to predict the intention to adopt a specific behavior: the attitude and the perceived behavior control. The attitude, generally defined as “the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question” was evaluated by requesting whether farmers have a favorable opinion or not on AES. The perceived behavior control, generally defined by “the perceived ease or difficulty to perform the behavior”, by requesting farmers whether respecting the technical prescriptions of the AES on their farm was easy or not. The questions, variables and the coding of the answers are summarized in Table 13. Details of the questionnaire are in appendix 3.

Variable	Description	Coding of the answers
<b><i>Farmers and farm socio-economic characteristics</i></b>		
Age	Age of the farmer	Years
Education	Education	0= Primary or secondary short 1=Superior or Secondary long
Area	Size of the farm	Ha
Profitability	How do you judge the profitability of your activity?	0=Not profitable or low profitability 1=Rather or very profitable
Successor	Do you believe someone will carry on farm activities after you retire?	0=No; 1=Yes
New activity	Have you had important change in your farm in the last 5 years?	0=No; 1=Yes
Origin	Do you produce wine under a protected geographical origin label?	0=No; 1=Yes
Cooperative	Are you member of a cooperative winery?	0=No; 1=Yes
<b><i>AES</i></b>		
Info	Have you been informed about the possibility to sign an AES?	0=No; 1=Yes
Sign AES	Have you decided to sign an AES in 2015?	0=No; 1=Yes
Intention	Do you have the intention to sign an AES in the two following years (2016, 2017)?	0= Very or rather unlikely 1= Very or rather likely
Past AES	Have you already signed an AES in the past?	0=No; 1=Yes
Attitude	Your opinion on AES is:	0=very unfavorable, rather favorable or no opinion; 1=rather favorable or very favorable
Easiness	Adopting an AES for my farm is:	1=Rather easy or very easy 0=Very difficult, rather difficult or neither easy nor difficult
<b><i>Social Norms</i></b>		
Injunctive norm (others)	The people, that are important to me, think I should adopt an AES	1= strongly disagree; 2=disagree; 3=neutral; 4=agree; 5=strongly agree (Agreement scale);
Injunctive norm (farmers)	The majority of wine-growers of my territory is favorable to AES	Agreement scale
Personal norm	I feel a moral obligation to modify my agricultural practices in order to improve the quality of water	Agreement scale
Reputation	How do the other farmers of the territory perceive a farmer that signs an AES?	1= very negatively; 2=negatively; 3=neither positively nor negatively; 4=positively; 5=very positively
Descriptive norm	According to you, what percentage of farmers of your territory will sign an AES in 2015	1=less than 5%; 2=between 5 and 10%;3=between 10 and 20%; 4=more than 20%

Table 13: Coding of the questionnaire variables

### 3.3.2 Data analysis

In this survey, two variables can be analyzed to capture the behavior in terms of AES: the actual decision to adopt an AES in 2015 and the intention to adopt in the 2 following years. In a first basic approach, we analyze the actual decision to adopt with a standard logit estimation. This variable however does not capture the opinion of those who have a strong intention to adopt an AES in the coming years. We therefore create a variable that takes value 0 for farmers who consider very or rather unlikely their adoption of an AES in the following 2 years, 1 for farmers who consider very or rather likely their adoption of an AES in the following 2 years and 2 if they have decided to sign an AES in 2015 (Variable AES). The variable AES is analyzed using a proportional odds ordered logit model (McCullagh, 1988).

We define a latent variable  $y^*$  that represents a level of utility, which is unobservable and defined by:

$$y^* = X'\beta + \epsilon$$

where  $X$  is a vector of variables that are considered to explain AES adoption,  $\beta$  is the vector of coefficient and  $\epsilon$  the residual.

The variable AES, here  $y$ , takes the value 0,1 or 2 if the latent variable is comprised between 2 thresholds ( $\alpha_1$  and  $\alpha_2$ ):

$$y = 0 \text{ if } y^* \leq \alpha_1$$

$$y = 1 \text{ if } \alpha_1 < y^* \leq \alpha_2$$

$$y = 2 \text{ if } y^* > \alpha_2$$

The probability to choose level  $j$  can be defined by:

$$p(y = j) = p(\alpha_{j-1} < y^* \leq \alpha_j) = F(\alpha_j - X'\beta) - F(\alpha_{j-1} - X'\beta)$$

where  $F$  is the logistic cumulative distribution function. This model produces one set of coefficients with 2 intercepts. The underlying proportionality of odds assumption is that the coefficients that predict the change from one category of the outcome variable to the next are the same along the scale. An approximate likelihood-ratio test is performed in order to verify that this assumption is verified.

### 3.3.3 Results and discussion

57% of farmers of the sample have decided to sign an AES in 2015. 33% of the farmers have not signed and consider their participation “very unlikely” or “rather unlikely”. 10 % have not signed but consider their participation “rather likely” or “very likely”. The resulting variable AES is described in Table 14.

AES	Freq.	%
0	32	33%
1	10	10%
2	56	57%

Table 14: Descriptive statistics of the variable AES that integrates effective participation decisions

Descriptive statistics of the various social norm variables are presented in the graphics below (Figure 11). They highlight the fact that farmers tend to choose the neutral response for injunctive norm variables such as the perception of injunctive norm exerted by important others, by farmers as well as the perceived reputational effect of signing an AES. The personal norm for the modification of agricultural practices is rather well established and the perception of the descriptive norm is uniformly distributed in the sample.

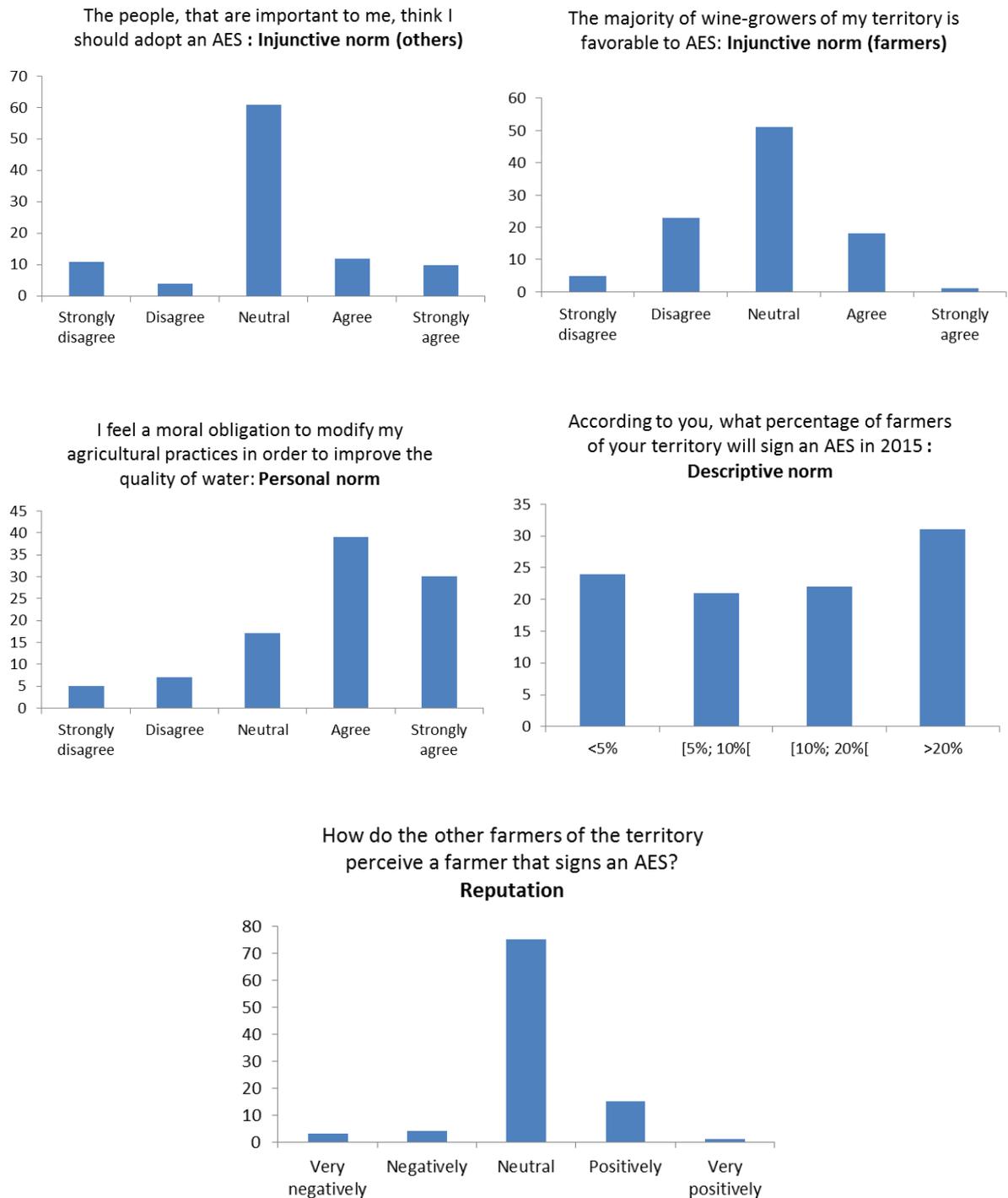


Figure 11: Descriptive statistics of the social norm indicators (In y axis is the number of farmers)

The Pearson's correlation between the norms variables are presented in Table 15.

	Injunctive norm (others)	Injunctive norm (farmers)	Reputation	Descriptive norm	Personal norm
Injunctive norm (others)					
Injunctive norm (farmers)	.161				
Reputation	.180	.298*			
Descriptive norm	.185	.348*	.202*		
Personal norm	.296*	.184	.191	.214*	

Table 15: Pearson's pairwise correlations between social norm indicators. (\*: Significant 5% min)

The level of correlation between social norm indicators remains relatively low, indicating that they represent different dimensions of the influence of social norm. The perceived injunctive norm from farmers, the descriptive norm and the reputation are nevertheless significantly correlated. These three dimensions indeed reflect the perceived norm amongst farmers. The injunctive norm perceived from important others and the personal norm are also significantly correlated. This could reveal a stronger alignment of personal beliefs and the beliefs of people important to farmers (who may not be other farmers). Finally, personal norms and the descriptive norm are also significantly correlated with no clear possible interpretation. Nevertheless, the correlations remain low (below 0.4) and we consider that they represent different dimensions of the influence of the norm. They could therefore be separately included in the analysis to estimate the participation to the AES.

Considering the large amount of neutral response, we decided to dichotomize the social norm indicators. When the initial variables take value 4 or 5 (3 and 4 for the descriptive norm), the new variable takes value 1 and 0 otherwise. We also decided to discard the indicator reputation that had a too high level of neutral responses.

The estimations using the logit (1) and the ordered logit (2) with the results of the web-survey are presented in Table 16. We also carry out an analysis with data of the TPB survey and the web-survey pooled together. Not all variables were in common, they could therefore not all be included in the analysis. We also add a dummy variable (TPB) that takes value 1 for the TPB survey data and 0 for the web-survey, in order to control for the difference between the two

surveys (different questionnaire, face-to-face vs web survey). We present only the results of an ordered logit estimation for this data (3).

Variables	(1)	(2)	(3)
Age	-0.08**	-0.07**	-0.04
Education	-0.93	-0.89	-0.72
Area	0.01	0.01	0.02
Profitability	-0.53	-0.57	-
Successor	0.79	1.09	-
New activity	0.18	0.26	-
Origin	0.83	0.79	0.78
Cooperative	0.12	0.05	0.01
Info	1.61**	1.39*	1.23*
Past AES	0.11	0.36	-0.22
Attitude	1.08*	1.07*	0.70
Easiness	1.19*	1.70***	1.74***
Injunctive norm (others)	2.22*	2.34**	2.34***
Injunctive norm (farmers)	1.34	1.03	-
Personal norm	1.24**	1.29**	1.76***
Descriptive norm	-0.40	-0.37	0.20
TPB	-	-	-2.9***
$\alpha_1$	-	-0.59	0.80
$\alpha_2$	-	0.19	1.74
Nb. Of observations	96	96	137
Pseudo R2	0.38	0.32	0.30
Log Likelihood	-40.99	-60.60	-92.55
LR chi2	49.6	56.5	81.1
Proportionality of odds	-	NS	NS

Table 16: Logit and ordered logit estimation of participation to AES schemes for the web-survey and ordered logit estimation for the TPB survey and the web-survey pooled together. \*\*\* \*\*and \* refer to significance at the levels of 1%, 5% and 10%, respectively.

**The analysis reveals that three variables are strongly and consistently involved in the decision to adopt or not an AES: the perceived difficulty linked to the adoption, the injunctive norm from others and the personal norm.** The first variable, our indicator of costs, reveals that, as the standard theory claims, farmers that have the less difficulty to adopt, i.e. farmers for which the cost associated with adoption are lowest, are more likely to participate in AES.

We confirm that farmers are consistently influenced by the injunctive norm exerted by people that are considered important by farmers. If they believe that these people have a favorable opinion, they are more likely to participate. In chapter 1, we decomposed the importance granted to the opinion of different category of people. It revealed that spouse and technical resource persons (referent farmers or technical advisors) are the most influential.

Finally, farmers that hold a strong personal norm, i.e. those who feel a moral obligation to modify their agricultural practices to improve water quality, are also the most likely to adopt an AES. Personal norm are generally considered to be an internalized form of injunctive social norms (Thøgersen, 2006). It is therefore likely that some farmers have been exposed for several years to a social pressure to modify their agricultural practices and have therefore integrated this pressure into a personal norm. This norm intervenes as a strong driver in the participation in agri-environmental policies.

On the other hand, the descriptive norm and the perceived opinion of farmers on AES do not have an impact on the probability to accept an AES. This lack of effect of descriptive norm, and the perception of the injunctive norm from other farmers could be interpreted in different ways. The first and obvious interpretation would be that farmers are not influenced by other farmers. This conclusion would mean that normative interventions may better focus on the norm imposed by other stakeholders (family, technical referents) rather than on the norm imposed by other farmers. This lack of influence may also well be due to the fact in all replies received, the percentage of farmers estimated to adopt remains too low for farmers to perceive a descriptive norm that imposes them to adopt an AES (see the model in 2.3). This lack of heterogeneity in our data therefore prevents us from identifying a potential role of the descriptive norm.

The second possible interpretation of this limited effect may be the lack of salience of the descriptive norm. Indeed norms are considered to influence behavior when they are sufficiently salient (Cialdini *et al.*, 1990). The limited influence of the decision of others on farmers' decision may therefore be due their lack of salience when they take the decision to either participate or not.

Finally, some variables influence the decision to sign an AES only in some models or to a lesser extent: younger and better informed farmers are more likely to adopt. The attitude,

which is the opinion on AES, intervenes also positively in the adoption of these contracts but only in model 1 and 2.

The results obtained in this empirical study bear a number of limits. The first limit is that the size of the sample is relatively small. The aim of this study, as compared to the TPB survey was to elaborate a simplified questionnaire that could be administered by internet and reach a larger sample of farmers. The involvement of AES facilitators of the Languedoc Roussillon in the survey was a way to reach the largest possible population. However, despite several reminders by facilitators and the research team, the response rate remained relatively low (14%), which is a general problem of this type of surveys. A possible extension of this study would therefore be to increase the geographical coverage of the survey at the national level. The fact that the results of the TPB survey and the results of the online survey are consistent however gives us some confidence on the conclusion of the importance of injunctive norms in the decision to adopt an AES.

The second limitation is the causality link between explanatory variables and the decision to adopt an AES. Stated preference surveys generally bear this limitation. We tried to limit the reverse causality problem by carrying our assessment concomitantly with their decision to adopt an AES so that they did not change their perception of social norm after having adopted an AES for some time. However, this bias could not be fully controlled as, for example, farmers that have decided to sign an AES may self-justify themselves by stating that they are supported by their relatives. One option to overcome this problem would be to use experimental methodologies described in section 3.2. This approach is envisaged for future research.

## 4 Conclusion and policy recommendations

In this chapter, we have theoretically highlighted the role of injunctive and descriptive social norm. Interestingly in the early stage of introduction of AES, the injunctive norm stimulates participation while the descriptive norm acts as an obstacle. In certain cases, the concomitant effects of both norms may lead to a stable state with a relatively low level of participation that is difficult to overcome. Our empirical study revealed the role of the injunctive social norm and the personal norm in farmers' decision to enroll in AES, along with the traditional role of the cost of adopting an AES. The descriptive role does not appear to be currently a driving force. How should these findings change the way agri-environmental policies are designed and implemented?

The economics literature suggests a set of common policy recommendations to harness the role of social norms in public policies. One of the main policy recommendations that comes out of the social norm models in economics is to take into account the multiplier effect generated by social norm to design optimal incentives. In simple terms, governments taxes or subsidies increase individual contribution and at the same time the social pressure which increases the impact on participation (Rege, 2004; Fischer and Huddart, 2008; Benabou and Tirole, 2012). The more social credit an individual receives the less he will need monetary incentives to contribute. It is therefore possible to obtain a higher level of outcome with the same level of incentives (tax, subsidy or wage) or to use fewer incentives for the same level of outcome. In our case study, the descriptive norm does not appear to be a clear driver in the participation to AES. According to our theoretical model, this type of multiplier effect may intervene only when a certain level of participation is already attained, which has not yet been reached. Therefore, we cannot assume a multiplier effect of the payments included in the contract or a possible reduction of payment that would take into account the utility generated by the fact that more people participate, except when participation rates are already quite high.

We consider that taking into account the role of social norms in agri-environmental policies could be either done by modifying the salience of norms ( $\lambda$  for the descriptive norm or  $\sigma$  for the injunctive norm in our model), modifying the norm itself or modifying its perception. These policy interventions could be either based on communication campaigns, nudges or the modification of AES.

**Saliency** is an important aspect to consider in the design of communication campaigns (Cialdini *et al.*, 2006). Considering that the descriptive norm currently has a limited impact in our empirical analysis, one possible option would be to increase the influence of this social norm by increasing its saliency  $\lambda$ . Precautions however need to be taken when using campaigns focused on saliency. For example, communication messages that insists on the anti-social behavior of some people such as “look at all these people doing this undesirable thing” may have no effect or even have backfiring effects by normalizing unwanted activities. In an experiment run in the Petrified Forest in California, different signs were tested: one that urged visitors not to take wood and depicted 3 people stealing wood and another one with the same message that depicted only one person stealing wood. People exposed to the former were significantly more likely to steal than the ones exposed to the latter (Cialdini, 2007). Insisting on the fact that farmers pollute the environment or do not adopt AES may therefore not be a promising policy intervention.

One approach could be to strengthen communication on the adoption of other farmers and/or the opinion of other farmers during the period in which farmers decide to adopt. This type of intervention may however also not be effective or even counter-productive in situations where participation is low. We have seen in our model that the descriptive norm tends to limit participation when participation is already low. In situations with a high rate of antisocial conduct, the theory clearly recommends to communicators to induce a normative focus on injunctive norm and not on descriptive norm (Cialdini *et al.*, 2006).

Our empirical results reveal that farmers are rather susceptible to the injunctive norm (a high  $\sigma$ ). Policies could therefore indirectly increase participation in AES **by strengthening the injunctive norm**. Our results show that farmers are more sensitive to the opinion of people who are important to them in their decision to adopt or not an AES, and not necessarily the opinion of farmers. Results of chapter 1 provides more information on the people who are mostly important to farmers in their decision to adopt an AES: referent technicians, spouses and some referent farmers. These categories of people may be the target of extension and communication efforts. They will in turn increase the social pressure on farmers who may be more willing to adopt AES.

The importance of **personal norms** in the adoption of AES also calls for the use of information campaigns that target this factor. According to Schwartz (1977), personal norms are activated when people are aware of the consequences of their action on others and feel a

personal responsibility for undertaking an action. Many efforts are currently targeted at informing farmers on the consequences of their agricultural practices on the environment or on their own health. These efforts should be maintained as they contribute to the activation of personal norms.

One final policy option is to target the **perception of the norm** (the perception of  $x$  in our model). Communication messages are often targeted at norm misperceptions. “*Lifting the veil*” (Bicchieri, 2006), i.e. modifying the perception of the norm is indeed much easier than modifying the norm itself. The example of campaigns aiming at correcting these misperceptions in order to reduce alcohol overuse is a famous example of effective normative campaigns (Schroeder and Prentice, 1998). A number of universities have tested these approaches and report a minimum reduction of 20% of high-risk drinking rates (Berkowitz, 2004). In this chapter, we also presented the results of a normative nudge implemented by Kuhfuss et al. (2016). Informing farmers that 80% of farmers declared they would maintain their pro-environmental practices after the end of their contract did significantly impact their decision to maintain their practices. Using this approach may however only be effective when there is misperception and when participation is already high enough (above  $x'$  or  $x''$  in our model). We may not be in this situation for the participation to AES. In these cases, there is a temptation to manipulate information, by raising figures on actual participation. The credibility of social norm communication campaigns is however fundamental when the regulator decides to disclose the information that he finds most suitable to obtain the expected result. Examples of failure of social norm campaigns that used data considered unreliable by the target population are reported in Berkowitz (2004).

Another more promising possibility would be to ensure that the design of AES itself modifies the perception of the descriptive norm, by modifying beliefs on the behavior of other farmers. This modification may change the descriptive norm into an incentive to participate in AES. Kuhfuss *et al* (2014) demonstrate, using a choice modeling, the impact of a bonus paid to farmers in cases where more than 50% of farmers of the territory participate in an AES. The positive results of this mechanism could be attributed to the fact that it induces beliefs of a high farmers' participation. The experimental work described in Chapter 3, which tests a payment system fully conditioned to a minimum participation of farmers, examines the potential effectiveness benefits of raising farmers' perception of the descriptive norm.



## **PART II**

# **WHAT IS THE PERFORMANCE OF INNOVATIVE AES DESIGNS AND HOW IT IS AFFECTED BY BEHAVIORAL FACTORS?**

---



## CHAPTER 3

# CAN COLLECTIVE CONDITIONALITY IMPROVE AGRI-ENVIRONMENTAL SCHEMES?

## Insights from experimental economics<sup>6</sup>

### Introduction

Several explanations are advanced to explain the unsatisfying outcome of AES. One of them is that most contracts are action-based, land managers are paid based on the pro-environmental actions they undertake (reduction of input use, land set-aside) whatever the ultimate environmental outcome. This system may be particularly problematic in situations with environmental threshold effects, i.e. when the production of environmental benefits does not increase linearly with environmental efforts but presents discontinuities (Perrings and Pearce, 1994; Muradian, 2001). For example, risks of eutrophication of water bodies are reduced only if the water concentration of phosphorus and nitrogen falls below a certain threshold. Efforts in terms of agricultural practices reducing fertilizer leakage must be provided at a sufficient level at the scale of the watershed to attain this threshold. If the sum of pro-environmental efforts is not sufficient, the environment does not improve and public funds are spent without any tangible benefit (Dupraz *et al.*, 2007).

In order to overcome the limitations of action-based agri-environmental contracts, authors have proposed the use of result-oriented contracts. The main principle is that land managers are paid not to perform specific management actions but rather to achieve set environmental outcomes (Burton and Schwarz, 2013). In addition, incentives can be set in a way to provide ecosystem services efficiently (Zabel and Roe, 2009). Result-oriented schemes studied in the literature consider however that environmental results are achieved at the individual farm level, but in the case of environmental threshold, obtaining a tangible environmental outcome requires a collective efforts and targets therefore must be collectively achieved. In this article, we intend to test, in a lab experiment, contracts in which individual payments are conditioned to the collective attainment of the threshold of environmental production. In this mechanism,

---

<sup>6</sup> This chapter is a modified version of Le Coent P., Preget R. and Thoyer S., 2015. Can collective conditionality improve agri-environmental contracts? Insights from experimental economics *presented at 7th Annual BIOECON Conference, Cambridge, 2016*

amounts paid depend on individual efforts as in action-based contracts, but payments are only triggered if the environmental threshold is collectively attained. The intuition behind the mechanism is that first the conditionality avoids to “pay for nothing”, i.e. say pay farmers without ultimate environmental results thereby generating efficiency gains. Second, the threshold may modify the perception of the descriptive norm, reassure farmers that others will participate and in turn increase participation, thereby improving the effectiveness of AES.

In result-oriented schemes, the risk of not obtaining an environmental outcome, due to bad management practices or natural hazard, is shifted from the regulator to land managers (Derissen and Quaas, 2013). We do not consider this exogenous risk here. In contracts, with collective conditionality, the idea is rather to transfer the risk of a lack of coordination. In this article, the issue at stake is therefore to measure whether the deterrent effect on potential participants of a no-payment outcome (if the threshold is not attained) is stronger or weaker than the incentive to coordinate at the threshold level. Aversion to risk and beliefs on the behavior of others will therefore be key factors to consider in the success of such mechanism.

This article therefore aims at answering our research question 3:

*Does the introduction of a conditionality on collective participation improve the effectiveness and efficiency of AES contracts in presence of environmental threshold?*

The *ex-ante* evaluation of policy measures has traditionally been evaluated using models or surveys. There is however a growing interest in using experimental economics as a “wind tunnel” to assess new policies and assist decision-makers. In this chapter, we use a decontextualized lab experiment in which we draw an analogy between agri-environmental contracts and an incentive system subsidizing voluntary contributions to a threshold public good. The experiment is designed to fit the issues of agri-environmental contracts: the traditional action-based agri-environmental contract is represented in the experiment by an unconditional subsidy to individual contribution to the public good (US) and our contract with collective conditionality corresponds to the conditional subsidy scheme (CS) paid only to contributors if the threshold of the public good is reached by the group. First, we test the performance of this conditional subsidy scheme in terms of effectiveness and efficiency. Second, we investigate behavioral explanations of these performances. We particularly evaluate the role of risk aversion and expectations about the behavior of other members of the group to understand why some groups manage to cooperate above the threshold, while others fail despite the incentive of a subsidy scheme.

This paper is organized as follows. A review on agri-environmental contracts with collective conditionality is presented in section 1. Section 2 describes the experimental design. Section 3 analyses the experimental results and section 4 concludes, drawing recommendations on the design of agri-environmental schemes.

## **1 Agri-environmental contracts with collective conditionality**

Although agri-environmental contracts with collective conditionality are relatively rare, there are few theoretical and empirical articles in the literature that deal with similar mechanisms<sup>7</sup>. Dupraz et al (2007) study the optimization of agri-environmental contracts in the presence of threshold environmental effects. The authors first develop a theoretical approach based on a principal-agent model in a context of information asymmetry on farmers' willingness to receive to adopt pro-environmental practices. One of the conclusions is that the establishment of a collective conditionality to trigger payments to farmers, a minimum threshold of contracted acreage, avoids welfare losses because subsidies are spent when environmental results are obtained. This approach has been implemented in the Ille-et-Vilaine Province, France, where the local administration promoted the use of grass strips along river banks to improve water quality. A first experience of individual AES-like contracts led to a very scattered and ineffective adoption of this practice. Public authorities therefore determined that a minimum threshold of 60% of the riverbanks of the targeted streams had to be reached to initiate payments to farmers. Interviews with managers of this programme revealed that this threshold was reached for some of the targeted streams. However, this was mainly obtained thanks to the facilitation and advocacy work of technicians on the ground that convinced farmers to enroll. Indeed, the measure was not financially attractive for farmers as only a small portion of the plots (about 20 meters along the river) was eligible for compensation payments.

A similar system is implemented in Oregon in the framework of the Conservation Reserve Enhancement Program (CREP). This programme aims at establishing riparian vegetation on agricultural land along streams to improve water quality and protect wildlife habitat. In this programme, landowners receive a Cumulative Impact Incentive Bonus (CIIB) equivalent to 4 years of annual rental rate if they (individually or collectively) enroll over 50% of the streambank in a 5-mile segment (ODA, 2005). This collective conditionality was created to

---

<sup>7</sup> This section was partially integrated in Kuhfuss et al. (2015)

encourage the conservation of continuous riverbank in view of having a more significant impact on water quality and ecosystems. In this case, the conditionality applies only to a bonus payment and not to the whole subsidy, as in the Ille-et-Vilaine case.

The potential impact of a bonus with collective conditionality was also tested in a choice modeling carried out in the Languedoc Roussillon region, France on the reduction of herbicide use in vine growing (Kuhfuss *et al.*, 2014). In this choice experiment, farmers' Willingness To Receive (WTR) to reduce their herbicide use, i.e. the amount of subsidy they would require to change this practice, is determined based on their choices among different contracts. For example, one of the possible contract characteristic is to receive an additional bonus provided at the end of the 5-year contract only if 50% of the surface of the targeted territory is ultimately enrolled. Interestingly, the analysis of farmers' choices demonstrated that farmers, if proposed this collectively conditioned bonus, have a higher probability to enroll and have a lower WTR (lower than the individual payment minus the expected additional bonus) than when the bonus is not included in the contract design. This result could therefore mean that higher level of enrollment could be obtained with the same level of public expenditure, if this type of measure would be implemented.

Although out of the scope of this study, the ambient tax scheme proposed by Segerson (1988) is also a (negative) incentive mechanism with collective conditionality. This mechanism was developed specifically to manage problems of uncertainty on the relationship between individual emissions and ambient pollution, which is the general case for non-point source agricultural pollution. Direct regulation could be used if it was economically feasible to monitor the practices of all polluters or if individual emissions could be inferred from measures on the environment. However the relationship between emissions and pollution is often stochastic and it is not feasible to determine the level of individual emissions out of measures of ambient pollution, since ambient pollution levels depend on the behavior of all. The incentive scheme proposed is a tax/subsidy scheme that is not based on individual abatement efforts but rather directly on ambient pollution levels. This mechanism is similar to a collective incentive mechanism for which the conditionality of the tax/subsidy is directly based on the level of an environmental indicator.

In this study, we will focus on agri-environmental contract for which the payment is integrally conditioned to the attainment of the threshold of production of the environmental good. We consider here that the regulator and the participants of the programme have a perfect

knowledge on the link between efforts and environmental outcome. Although this is a simplification, our interest was to focus on the strategic risk that exist between farmers and if the mechanism we propose could solve it.

## 2 Experimental design and procedure

Experimental economics is increasingly being used to assist decision makers in policy design. We follow this approach to test agri-environmental contracts with collective conditionality. This section presents our treatments, the experimental protocol and the theoretical predictions.

### 2.1 Treatments

Farmers' choice to adopt pro-environmental practices can be modeled by voluntary contributions to a public good. Indeed, farmers adopting these practices generally bear private costs whereas the environmental improvement benefits everyone. In situations in which environmental production presents thresholds, our problem is better captured by a threshold public good. The game underlying the experiment is therefore a threshold public good game. The benchmark treatment is the threshold public good game with no subsidy called the *Provision Point Mechanism* (PPM) and the two treatments of interest in this paper are:

- **US**, a treatment with an *Unconditional Subsidy* paid to all contributors proportionally to their contribution whatever the outcome in terms of public good production, and
- **CS**, a treatment with a *Conditional Subsidy* scheme paid only if the threshold is reached by the group.

In our applied context (Table 17), the PPM represents the situation without AES, the US represents the actual AES in which farmers receive individually a subsidy for each hectare they enroll and the CS represents the subsidy scheme that we want to test, a subsidy by ha enrolled that is paid to each enrolled farmer provided that the sum of agricultural land enrolled exceeds the threshold necessary to ensure an environmental improvement.

Context	Transposition in the laboratory
Threshold environmental public good such as water quality or biodiversity conservation	Threshold public good
Farmers	Participants in the experiment (students)
Cost related to the adoption of pro-environmental agricultural practices	Contribution to the public good
Traditional agri-environmental contract: payment to each farmer per ha enrolled whatever the environmental outcome and the decision of others	Subsidy proportional to individual contribution: unconditional subsidy scheme (US). In our case, we consider that the subsidy covers only partially the cost of implementation of AES.
Agri-environmental contract with collective conditionality: payment to each farmer per ha enrolled provided the sum of ha enrolled by all farmers is greater than the required threshold to ensure an environmental outcome.	Subsidy proportional to the contribution triggered if the threshold of the public good is collectively attained: conditional subsidy scheme (CS)

Table 17: Transposition of the context into the laboratory

This experiment is run with groups of 4 subjects that represent a community of farmers in a given territory. Each subject  $i$  is endowed with 20 tokens, and must decide how many tokens ( $C_i$ ) to contribute to a public account which benefit to all members of the group only if the threshold is reached. In the three treatments, the threshold is set at an intermediate level of 40 tokens which represents 50% of the total endowment of the group ( $4 \times 20$ ). In addition, we consider that the public good keeps increasing beyond the provision point which is similar to the public good production function in Isaac et al. (1989). The value of marginal per capita return (MPCR) from investing in the public good when the threshold is reached is set at 0.3 which is a value quite low compared to most experiments in the literature, but this choice is intended to reflect the low individual benefit perceived by the farmers from the public good in our applied context.

Therefore in the PPM treatment, subject  $i$ 's payoff ( $\pi_i$ ) is:

$$\pi_i = \begin{cases} 20 - C_i & \text{if } \sum_{i=1}^4 C_i < 40 \\ 20 - C_i + 0.3 \sum_{i=1}^4 C_i & \text{if } \sum_{i=1}^4 C_i \geq 40 \end{cases}$$

The US is similar to the PPM except that when subjects contribute  $C_i$ , they get an individual subsidy that is a proportion (0.3) of their individual contribution. This relatively modest

subsidy level is chosen to ensure that allocating money to the public account is not too attractive since we want to ensure that our experimental setting can be likened to the agri-environmental contract case.

Therefore in the US treatment, subject  $i$ 's payoff is:

$$\pi_i = \begin{cases} 20 - 0.7C_i & \text{if } \sum_{i=1}^4 C_i < 40 \\ 20 - 0.7C_i + 0.3 \sum_{i=1}^N C_i & \text{if } \sum_{i=1}^4 C_i \geq 40 \end{cases}$$

Finally, in the CS treatment, the individual subsidy remains proportional to the contribution but is paid only if aggregate contributions reach the threshold. Therefore, if the threshold is not reached, subject  $i$ 's payoff is the same as in the PPM treatment:  $20 - C_i$ , and if the threshold is reached, subject  $i$ 's payoff is the same as in the US treatment:  $20 - 0.7C_i + 0.3 \sum_{i=1}^N C_i$ . The total group earning according to the group contribution for the three treatments is illustrated in Figure 12.

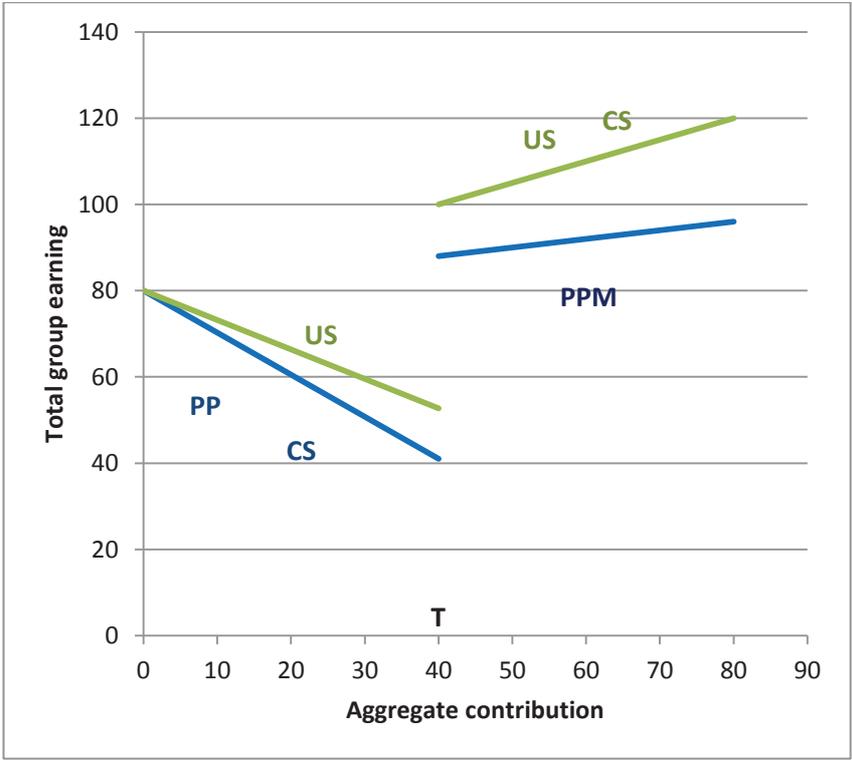


Figure 12: Total earning of groups as a function of aggregate contribution

## 2.2 Discussion of the design and theoretical predictions

Results presented in Isaac et al. (1989) and confirmed in most experiments show that introducing a threshold in a standard voluntary contribution mechanism can raise contributions (Suleiman and Rapoport 1992, Dawes and Orbell 1986, and Rondeau, Poe, and Schulze 2005). Actually, there is a multiplicity of non-cooperative equilibria in provision point mechanisms in which the sum of the group members' contributions equals the threshold and participants need to coordinate to select one (Ledyard, 1995). However, the threshold is not attained in all cases. Indeed, not contributing at all, i.e.  $C_i = 0, \forall i$ , is still an equilibrium in PPM. Theoretical predictions for the US and the CS treatments are qualitatively the same as for the PPM treatment, i.e. a multiplicity of equilibria for which  $\sum_{i=1}^4 C_i = 40$  and a zero contribution equilibrium. However the number of equilibria at the threshold is much higher. For the PPM treatment, the level of asymmetry among contributions in the group is bounded with a maximum contribution of  $C_i = 12$ . For contributions which are only integer numbers, there are 165 equilibria respecting this condition. For the CS and the US, the number of equilibria at the threshold is much higher (3551) since the maximum individual contribution rises to 17 tokens, with the parameters chosen in this experiment.

As in standard public good games, there is still a social dilemma in our three treatments. The equilibria at the threshold level Pareto-dominate the zero contribution equilibrium but are not Pareto optima. The Pareto optimum in the three treatments is that all players contribute their full endowment to the public good.

Failure to reach the threshold leads to net losses in terms of wasted contributions since the public good is not produced whereas contribution costs have been supported. To mitigate this problem, mechanisms such as money back guarantee<sup>8</sup> (Rapoport and Eshed-Levy 1989, and Cadsby and Maynes 1999) and rebate rules<sup>9</sup> (Marks and Croson 1998, and Spencer et al. 2009) are investigated in the literature. The subsidy schemes we test differ from these mechanisms, although they present similarities. When the threshold is not reached, the US is equivalent to a partial money back guarantee system, but in our US treatment, subject's contribution is partially reimbursed in any case, as it is the case in current agri-environmental contracts. In our applied context, a standard money back guarantee mechanism could

---

<sup>8</sup> A money back guarantee is a system that guarantees the reimbursement of contributions to the public good if the threshold is not reached.

<sup>9</sup> Rebate rules are used to compensate subjects for their excess contributions when aggregate contributions are beyond the threshold

correspond to an AES which would be implemented only if enough farmers enroll in the scheme so as to be certain to reach the threshold of producing the public good before incurring costs. The US and CS could also be considered as forms of rebate rules. However, subjects receive a proportion of their whole contribution to the public good whereas in classical rebate rules, contributors get only a proportion of their excess contributions beyond the threshold.

When comparing our treatments, note that the step return<sup>10</sup> in the PPM treatment equals 1.2, while it equals 1.5 in the two subsidy treatments (US and CS). Considering that the step return is a good predictor for successful provision in PPM experiments (Croson and Marks 2000, and Cadsby et al. 2007), we expect that this will lead to higher contributions and to more frequent successful provision of the public good.

In the US treatment, we may expect that unconditional subsidies encourage contributions even under the risk that the threshold is not reached since subjects know that they will get at least the subsidy (partial money back guaranteed or insurance effect). In the CS treatment, the fact that the subsidy is conditional may have two opposed impacts. On the one hand, the conditionality increases the risk of contributing, leading most pessimist or risk averse subjects to limit their contribution. On the other hand, the conditionality increases the focus on a level of contribution of 50% of the endowments. This may increase beliefs on others' contributions and in turn help solving the coordination issue. Therefore, we expect a higher variability between groups in the CS treatment depending on subjects' beliefs on reaching the threshold. However, we hypothesize that the use of the CS scheme will not reduce contributions significantly compared to the US scheme.

Since risk aversion and beliefs about others' contributions may influence the effect of the different treatments, we propose in this paper to elicit these two variables so as to include them in our behavioral analysis.

### 2.3 Protocol

This experiment is run in a “between-within” setting in order to compare the performance of the various treatments when they are applied successively to the same subjects or when they are applied to different subjects. The treatment sequences and the number of groups participating in each session are presented in Table 18.

---

<sup>10</sup> Step return =  $\frac{\text{aggregate group payoff from the public good}}{\text{total contribution threshold}}$

Sessions	Sequence 1 10 periods	Sequence 2 10 periods	Number of subjects	Number of groups
A	PPM	US	40	10
B	PPM	CS	40	10
C	US	PPM	40	10
D	CS	PPM	40	10
E	US	CS	28	7
F	CS	US	32	8
<b>Total</b>			<b>220</b>	<b>55</b>

Table 18: Treatments tested in each session of the experiment

The groups of 4 subjects remained the same during sequence 1 and sequence 2. The voluntary contribution game was repeated for 10 periods within each sequence. Each subject got a feedback at the end of each period on the aggregate contribution of his group to the public account and on his individual payoff.

We hypothesized that risk aversion and beliefs about others' contributions influence the effect of the different treatments. We therefore elicited these two variables. Risk aversion was elicited through a simple series of lotteries implemented at the beginning of the experiment. In 10 different games, subjects were requested to choose between a safe option with a gain of 20.5 points (lottery A) and an uncertain option in which they had a probability to earn 40 points and a probability to earn 1 point (lottery B). In game 1, the probability to earn 40 units was 10% and this probability increased by 10% in each following game. Subjects' risk aversion was characterized by their "switching point", *i.e.* the first game for which they chose the uncertain option. Individuals with multiple switching points were considered to have an undetermined risk aversion. To determine subjects' earnings, one of the games was randomly chosen and its outcome was determined using a randomized system. Subjects were informed that they would be told their earnings only at the end of the experiment.

To elicit subjects beliefs we used a protocol similar to Fischbacher and Gächter (2010): at each period, before subjects announced their contribution to the public good, each subject was asked to give his estimation of the contribution of the 3 other members of his group. If his estimation was accurate, he earned 5 points; if it was 1 token away from the actual contribution of others, he earned 4 points; if it was 2 tokens away, he earned 3 points; if it was more than 2 tokens away, he earned nothing. These points were added to the points earned in the contribution game. All the periods of a sequence were paid, but only one randomly chosen sequence was paid among the two sequences. Subject knew there would be 3 parts in the

experiment (risk elicitation, sequence 1 and sequence 2) but new instructions were given only at the beginning of each part of the experiment. Details of the instructions are provided in appendix 4.

Subjects were invited through the recruitment software for experimental economics ORSEE (Greiner, 2004). Experiments were conducted in 2013 and 2014 at the LEEM (Laboratoire d'Economie Expérimentale de Montpellier). 92% of the subjects were students from the University of Montpellier. 42% had already participated in an economic experiment but we made sure that none had participated in a public good experiment before. The experiment lasted a maximum of 2 hours and the average earning was 15.9€ with a standard deviation of 3.0€. Subjects were given an additional show-up fee of 2€ if they were students from the university site where the experiment was carried out and of 6€ otherwise.

### **3 Experimental results**

We first present experimental results at the group level, distinguishing the effectiveness of subsidy schemes based on group contributions (4.1) and their efficiency analyzing the welfare (4.2). Next, we investigate individual behavior (4.3) through individual data on contributions, subjects' beliefs on the contribution of the other group members, and subjects' risk aversion.

#### **3.1 Effectiveness of the subsidy schemes**

We first analyze the effectiveness of the various treatments by examining graphically group contributions in the 6 sessions of the experiment (Figure 13). As expected, group contributions seem to be higher with subsidy treatments than with the PPM and the level of contribution seem to be quite similar with the two subsidy treatments. We can also observe a decay of contributions over the periods of the experiment, throughout treatments, as generally reported in public good experiments. Finally, subsidy treatments seem to be particularly effective when they are applied in the second sequence of the experiment.

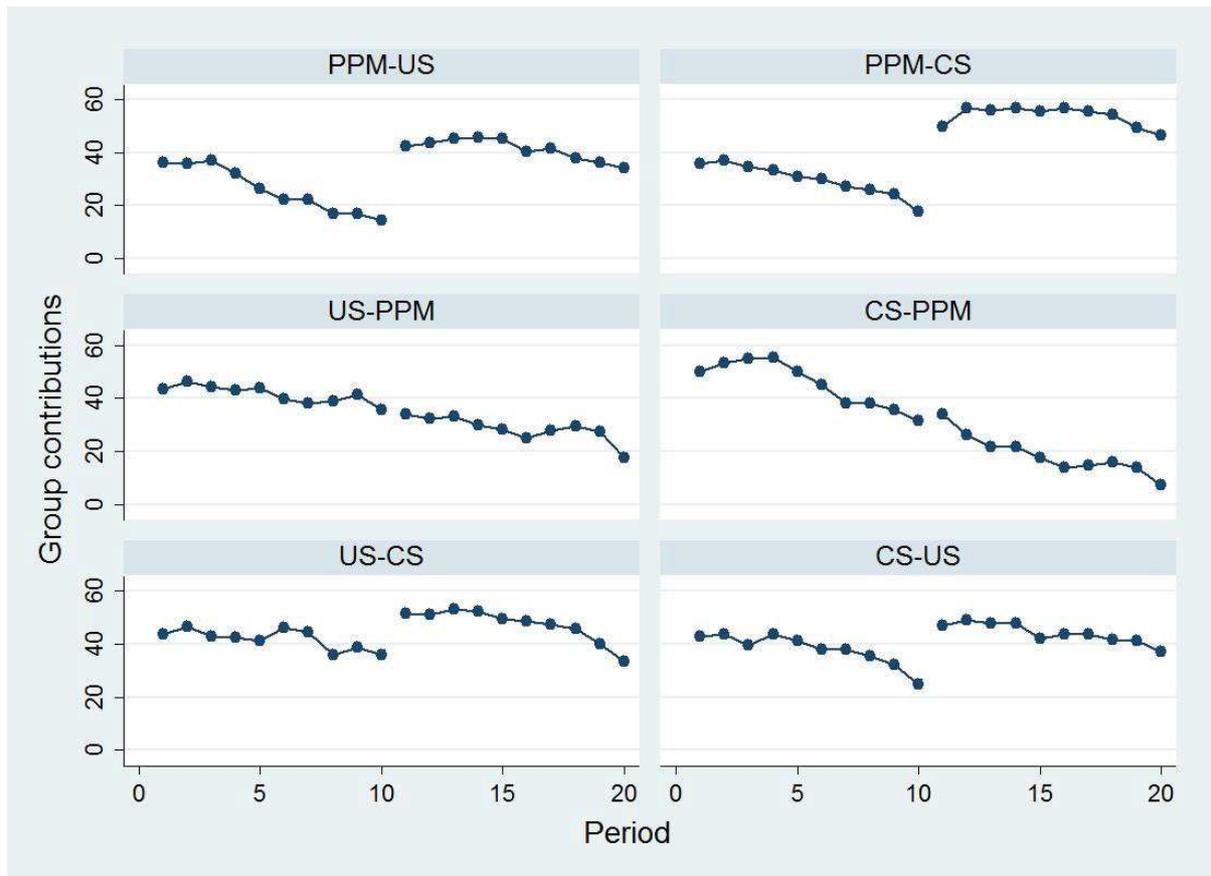


Figure 13: Average group contribution by period in the 6 sessions of the experiment

Average group contributions within each session (averaged over the ten periods) and frequency of success of public good production are presented in Table 19. Both the Wilcoxon paired test on average contributions and the chi2 test on the frequency of success confirm that the two subsidy treatments (US and CS) are more effective than the treatment without subsidy (PPM), either when the PPM treatment is applied before or after the subsidy treatments. However, the level of effectiveness is not significantly different between CS and US when these treatments are applied to the same group successively (sessions E and F).

Session	Sequence	Treatment	Number of groups	Average group contribution	Wilcoxon paired test	Success	chi2 test
A	1	PPM	10	26.0	**	33%	***
	2	US		41.1		69%	
B	1	PPM	10	29.6	***	42%	***
	2	CS		53.7		86%	
C	1	US	10	41.5	***	62%	**
	2	PPM		28.4		45%	
D	1	CS	10	45.2	***	71%	***
	2	PPM		18.7		28%	
E	1	US	7	42.0	NS	63%	NS
	2	CS		47.2		75%	
F	1	CS	8	38.0	NS	59%	NS
	2	US		44.0		67%	

Table 19: Summary of sessions and within-group comparison of treatments using chi2 and Wilcoxon paired test (\*\*\*: significant at 1%, \*\*: significant at 5%, NS: not significant).

To provide firmer results, we use a between-analysis by comparing the 1<sup>st</sup> sequence of each session. The results confirm that group contributions are higher and that the public good is more frequently produced when subsidy schemes are implemented (Table 20 and Table 21). There is no significant difference between CS and US neither on group contribution nor on frequency of successful production of the threshold public good.

Treatment	Number of groups	Frequency of success	Pairwise chi2 test	
			PPM	US
PPM	20	38%		
US	17	62%	***	
CS	18	66%	***	NS

Table 20: Frequency of success of production of the public good in the first sequence of all sessions (\*\*\*significant at 1%, NS: not significant)

Treatment	Number of groups	Average group contribution	Mann Whitney U test	
			PPM	US
PPM	20	27.8		
US	17	41.6	**	
CS	18	42.0	**	NS

Table 21: Comparison of average group contributions in the first sequence of all sessions using the Wilcoxon Mann-Whitney test. (\*\*significant at 5%, NS: not significant)

This result is also confirmed when group contributions are analyzed using a panel regression with random effects<sup>11</sup> (Table 22). In addition, the analysis highlights the decrease of contributions over the 10 periods of the first sequence, traditionally observed in repeated public good experiments.

<b>Group contribution</b>	<b>Coef.</b>	<b>(Std. Err.)</b>
Intercept	52.3***	(4.6)
PPM (ref CS)	-14.2***	(6.2)
US (ref CS)	-0.4	(6.5)
Period (1 to 10)	-1.9***	(0.2)
Nb. of observations	550	
Nb. Of groups	55	
Wald chi2	142.39	
Prob chi2	0.00	

Table 22: Panel regression with random effects on group contributions in the first sequence of all sessions (\*\*\*significant at 1%).

In order to investigate further treatment comparison, we analyzed the data of all sessions pooled together. Treatment comparison is possible as treatments are represented in a balanced way in sequences 1 and 2<sup>12</sup>. We carried out a panel regression on all data. We included an additional dummy variable in order to control the potential effect of the sequence on contributions (Table 23).

<sup>11</sup> Random effect regression is used because we want to estimate the effect of time invariant variables such as treatments (PPM and US).

<sup>12</sup> For PPM: 20 groups in sequence 1 and 20 groups in sequence 2; For US: 17 groups in sequence 1 and 18 groups in sequence 2; For CS: 18 groups in sequence 1 and 17 groups in sequence 2.

<b>Group contribution</b>	<b>Coef.</b>	<b>(Std. Err.)</b>
Intercept	54.7***	(2.7)
PPM (ref CS)	-21.7***	(1.1)
US (ref CS)	-4.1***	(1.2)
Period (1 to 10)	-1.6***	(0.1)
Sequence 2 (ref 1)	1.6**	(0.8)
Nb. of observations	1100	
Nb. Of groups	55	
Wald chi2	593.34	
Prob chi2	0.00	

Table 23: Panel regression with random effects on group contributions with all data pooled (\*\*\*)significant at 1%, \*\*significant at 5%).

This panel regression reveals a positive effect of the conditional subsidy as compared to the PPM, as expected, but more interestingly as compared to the unconditional subsidy scheme on group contributions. The conditional subsidy leads to significantly higher group contributions (+ 4.1 tokens on average) than the unconditional subsidy system when all data are pooled together. This result strongly confirms the potential interest of this subsidy scheme for public policies.

### 3.2 Efficiency of the subsidy schemes

Subsequently, we compare the efficiency reached under the three treatments using a between analysis (comparison of sequence 1 of all sessions) provided in Table 24. Net “social gains” are a proxy for efficiency and are measured as the sum of players’ payoff minus public spending on subsidies.

<b>Treatment</b>	<b>Number of groups</b>	<b>Net social gains</b>	<b>Mann Whitney test</b>	
			<b>PPM</b>	<b>US</b>
PPM	20	74.3		
US	17	80.4	**	
CS	18	82.6	**	NS

Table 24: Comparison of net social gains in the first sequence of all sessions using the Mann-Whitney test. (\*\*significant at 5%, NS: not significant).

Both subsidy schemes generate net social gain improvements as compared to the classical PPM, which is a significant result in the debate on the usefulness of subsidy schemes. However, although we could expect a net advantage of the CS scheme over the US scheme, since the subsidy is paid only when the public good is produced, experimental results are less clear-cut. The net social gains generated by CS are not significantly different from those generated by the US treatment. This might be due to the heterogeneity of group contributions. However, when we pool all data together and carry out a panel regression analysis, we can emphasize that net social gains are superior with the CS scheme than with the US scheme (Table 25). This confirms our hypothesis of greater efficiency of the conditional subsidy system as compared to the two other treatments. As observed for group contributions, net social gains are also superior in sequence 2.

<b>Net social gains</b>	<b>Coef.</b>	<b>(Std. Err.)</b>
Intercept	83.2***	(1.4)
PPM (ref CS)	-8.0***	(1.0)
US (ref CS)	-2.0*	(1.1)
Period (1 to 10)	-0.1	(0.1)
Sequence 2 (ref 1)	4.3***	(0.8)
Nb. of observations	1100	
Nb. Of groups	55	
Wald chi2	99.11	
Prob chi2	0.00	

Table 25: Panel regression with random effects on net social gains with all data pooled together (\*\*\*)significant at 1%,\*significant at 10%).

The effectiveness and efficiency advantages of the conditional subsidy over the unconditional subsidy and the PPM emphasize the potential interest of agri-environmental contracts with conditional subsidy in situations of environmental threshold. The results of the conditional subsidy system are however quite variable across groups. Therefore the use of this type of mechanisms requires particular attention. In the rest of the article, we therefore investigate why some groups manage to cooperate above the threshold, while others fail despite the incentive of a subsidy scheme. We particularly focus on the analysis of the role of the first period of the experiment and on how behavioral factors, individual risk aversion and expectations about the behavior of other members of the group, may underpin the performance of the conditional subsidy system.

### **3.3 The crucial role of the first period of the experiment**

The graphic representation of the dynamics of group contributions throughout the first sequence of the experiment seems to reveal that the result of the first period is key to explain individual behavior (Figure 14). With the PPM, there is a high intra-group variability with generally more unstable contributions. In treatments with subsidy (US and CS), intra-group variability is rather low while inter-group variability is high. For the CS, two types of groups clearly emerge: groups that manage to coordinate over the threshold and groups that don't. Put in a simple way, the graph seems to indicate that if a group manages to coordinate in the first period, its aggregate group contribution remains over the threshold for most of the sequence, until end-game effects start appearing. However, if the group does not manage to coordinate at the threshold in the first period, its contributions rapidly converge at the zero contribution equilibrium. The US presents similar characteristics, however groups that do not coordinate above the threshold do not coordinate as rapidly towards the zero contribution equilibrium. Intermediate levels below the threshold are maintained, probably because losses are limited when the threshold is not reached thanks to the unconditional subsidy mechanism.

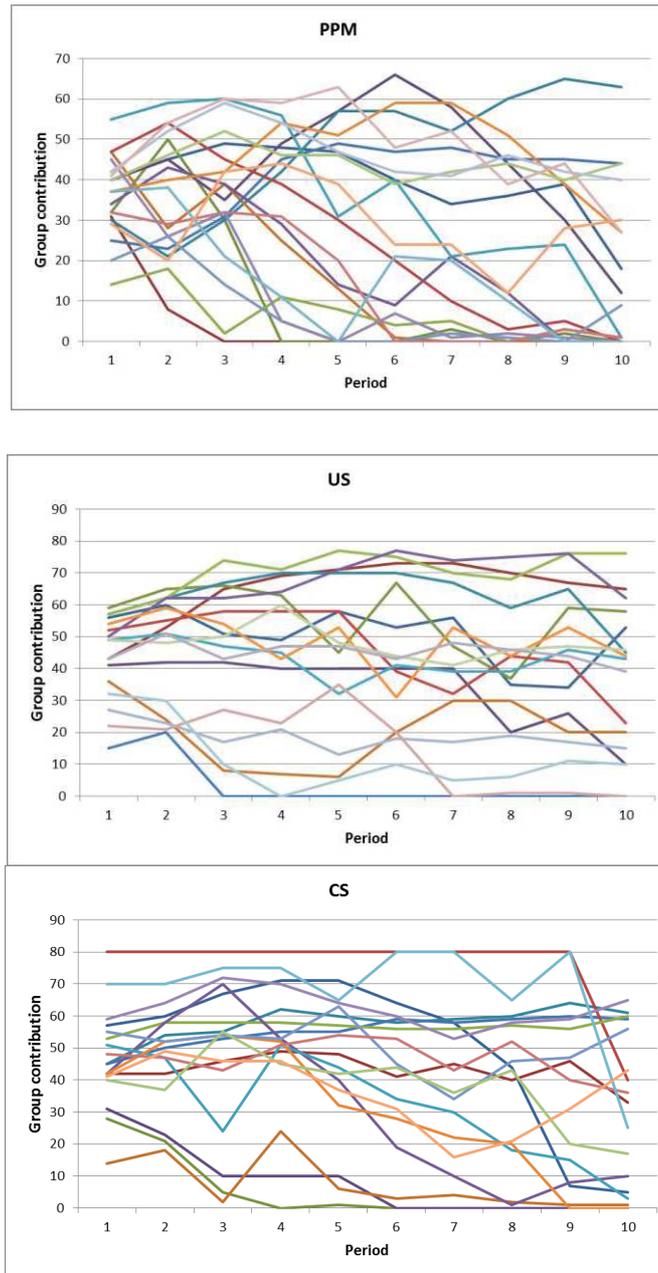


Figure 14: Aggregate group contributions for the different treatments (1 group=1 data serie) in the first sequence of the experiment

We statistically investigate this intuition with a panel regression on individual contribution (without the first period of the experiment), in which we include the success in the first period (group contribution  $\geq 40$ ) and the interaction with treatments, as exogenous variables (Table 26).

<b>Individual contribution</b>	<b>Coef.</b>	<b>(Std. Err.)</b>
Intercept	8.54***	(1.21)
CS	-4.04***	(1.44)
US	-2.23	(1.45)
Success in first period	3.06*	(1.77)
Success in first period x CS	7.82***	(2.02)
Success in first period x US	7.20***	(2.08)
Period	-0.53***	(0.09)
Nb. of observations	1980	
Nb. Of groups	55	
Wald chi2	553.2	
Prob chi2	0.00	

Table 26: Panel regression with random effects on individual contributions to the public account (errors are clustered at the group level and period 1 excluded) (\*\*\*significant at 1%,\*significant at 10%).

This regression confirms that the success in the first period has a significant positive effect on subsequent contributions. In addition, the interaction between the subsidy treatments and the first period success are highly significant and positive. This confirms that, with subsidies, if subjects contribute above the threshold in the first period they are likely to keep on doing so in the following periods. On the contrary, if the public good is not produced in the first period, contributions are lower in the conditional subsidy as compared to the PPM (the effect of CS becomes significant and negative) and contributions rapidly converge to the zero-contribution equilibrium. This analysis therefore reveals that one of the advantages of the conditional subsidy is that contributions remain stable if players successfully coordinate at the beginning of the experiment; if not, they rapidly converge to the zero contribution equilibrium. This could explain the advantages of subsidy treatments in term of effectiveness and the efficiency advantage of the conditional subsidy.

This result has implications on the implementation of AES with collective conditionality. The early stages of the introduction of such a mechanism in a community will require particular attention because a failure of coordination in this phase could have long-term negative effects. The use of this type of contract would therefore require the development of a thorough facilitation process to ensure that coordination above the threshold is reached directly in the early phases of the implementation process. In order to better understand the key aspects on

which this facilitation would need to focus, we investigate the behavioral factors that may intervene in the success of coordination in the first stage of implementation of agri-environmental contracts with collective conditionality.

### 3.4 The role of aversion to risk and beliefs

Since these experiments are coordination games, the *assurance problem*, as described by Sen (1967) and Runge (1984) might arise and explain individual behavior. Each player has a strategic uncertainty on the contributions of the other group members. Below a certain value of beliefs about others' contributions, there is no interest to contribute to the public good because the expected probability that the threshold will be reached is too low. When this value is reached, it is optimal to contribute to reach the threshold. Runge (1984) argues that the purpose of political and economic institutions, dealing with public goods, is the coordination of expectations and beliefs. Institutions should therefore provide assurance regarding the behavior of others, and thereby help mitigating the assurance problem. Our hypothesis is that subsidy schemes can play that role. Both subsidy schemes can therefore raise peoples' beliefs about others' contribution and facilitate coordination.

In order to verify these hypotheses, we compare beliefs on others' contribution in the first period of the first sequence for the three treatments using a t-test. Beliefs on others' contribution are indeed significantly higher with the conditional subsidy than with the two other treatments (Table 27).

Treatment	Number of subjects	Average belief	Standard Deviation	PPM	US
PPM	80	29.6	16.3		
US	68	31.5	12.9	NS	
CS	72	36.1	12.8	***	**

Table 27: Comparison of beliefs about others' contribution between treatments in the first period using the t- test (NS: not significant; \*\*significant at 5%; \*\*\*significant at 1%)

This positive effect of the conditional subsidy on the expectation about others' behavior is probably one of the explanations for the positive results of this mechanism. However, given this advantage, it is questionable why the conditional subsidy does not show an even clearer advantage in the rest of the experiment. One explanation could be that, considering that the subsidy is conditioned to the behavior of others, subjects are more cautious when they choose

their contribution in the first period. As we mentioned earlier, in this mechanism the exogenous risk of a lack of coordination is shifted from the regulator to the farmer. The assumption is therefore that the more subjects are risk averse the less they will tend to contribute out of fear of losing their contribution. In our applied context, the more farmers are risk averse, the less they will adopt pro-environmental practices, in fear of not reaching the environmental threshold and thus not receiving the conditional payment.

We test this hypothesis using data we elicited on risk aversion<sup>13</sup>. An OLS regression on individual contributions in the first period, confirms the significant negative effect of risk aversion on individual contributions in the first period (Table 28). However, although we anticipated that risk aversion would have a different impact depending on the treatment, we could not highlight this difference.

<b>Individual contribution</b>	<b>Coef.</b>	<b>(Std. Err.)</b>
Intercept	14.88***	(1.93)
PPM (ref CS)	-2.85***	(1.02)
US (ref CS)	-0.82	(1.06)
Aversion to risk (1 to 11)	-0.44*	(0.25)
Nb. of observations	203	
R <sup>2</sup>	0.05	
Prob>F	0.02	

Table 28: OLS regression on individual contribution to the public account in period 1 (\*\*\*)significant at 1%,\*significant at 10%)

A Mann-Whitney test however reveals that the average risk aversion of groups that fail to reach the threshold is significantly higher than the one of groups that succeed for the CS treatment (Table 29)<sup>14</sup>.

<sup>13</sup> Subjects’ aversion to risk is characterized by the rank of the switching point (see section 2.3). For individuals that switched several times the risk aversion value was considered missing. The risk aversion indicator is spread from 1 to 11 with an average of 6.96 and a standard deviation of 1.70.

<sup>14</sup> There is no significant difference of average group risk aversion between treatments.

Treatment	Average group risk aversion (Number of groups)		Mann Whitney test
	Threshold not reached in the first period	Threshold reached in the first period	
PPM	6.8 (9)	6.8 (11)	NS
US	7.1 (12)	7.0 (5)	NS
CS	6.9 (15)	8.2 (3)	***

Table 29: Comparison of average group risk between groups that success or fail to reach the threshold in the first period using a Mann-Whitney test (NS: not significant; \*\*\*significant at 1%)

Aversion to risk should therefore be particularly considered in the implementation of contracts with collective conditionality, considering that farmers are generally considered to be particularly risk averse.

## 4 Conclusion

Agri-environmental schemes are criticized because of their limited impact and their low cost-efficiency. One of the reasons for this disappointing outcome is that contracts are implemented without taking into account threshold environmental effects and the need to coordinate environmental efforts at a pertinent scale. We use a laboratory experiment to test a innovative of AES for which the payment is conditioned to the collective attainment of the environmental threshold. In addition to responding to the challenge for environmental threshold this mechanism may also modify the perception of the descriptive norms to strengthen participation.

In a laboratory experiment conducted with 220 students, we compare the effectiveness and efficiency of a standard provision point mechanism (PPM) and two subsidy schemes: an unconditional subsidy and a conditional subsidy paid only if the public good threshold is reached by the group. Results show that both subsidy mechanisms are more effective and more efficient than the standard PPM. More interestingly, the conditional subsidy performs as well as the unconditional subsidy and even better when the whole data is considered (sequence 1 and 2 of the experiment). In addition, the efficiency of the conditional subsidy is superior, mainly due to the fact that subsidies are not spent when the public good is not produced, which is politically attractive especially when budget constraints are tight.

The result of this mechanism is however variable depending on the group of subjects. Investigations of individual behavior show that contributions are strongly affected by the result of the first period, especially for subsidy treatments. If subjects manage to cooperate above the threshold in the first period, this cooperation remains stable in the following periods. However, groups that do not manage to cooperate above the threshold in the first period rapidly converge to the zero-contribution equilibrium. Considering the importance of the first period, we subsequently focus our analysis on decisions taken in the first period of the experiment. Both types of agri-environmental contracts, and especially the one with collective conditionality, positively affect contributions through a positive impact on the expectations on others' behavior in the first period. On the other hand, groups with more risk averse subjects tend to fail to coordinate especially when the payment presents a collective conditionality. Facilitation activities would therefore be crucial to strengthen trust and expectations on others' behavior as well as reducing the impact of risk aversion. The role of behavioral factors in the performance of innovative AES is confirmed in this experiment.

Because participants may increase their contribution, both because it is optimal to do so in the presence of a threshold, if they believe others will contribute, and because they may be subject to the effect of a descriptive social norm, it is not possible to disentangle these two rationales in our experiment. One possible extension of the work would be to carry out the same experiment using a standard public good experiment. In this setting, contributing at the level of the threshold would not be an equilibrium unless subjects also perceive non-monetary incentives associated with the social norm. From a policy perspective, the interest of introducing an AES with collective conditionality in the absence of environmental threshold would be to harness the effect of social norms and ensure a certain level of improvement of the environment.

In order to strengthen external validity of these results, obtained with students in the laboratory, field experiments with farmers would be needed to confirm the results. A first step would be to apply exactly the same protocol with farmers using a "lab in the field approach". In a second step, this mechanism could be tested in a contextualized experiment carried out with farmers, that would provide elements of the context. The ultimate test would be to experiment this mechanism on a pilot basis or, even best, using a randomized control trial. Implementing this last step is however complex given the administrative difficulties associated with the testing of incentives to farmers in the CAP context.

Transposing strictly the experiment to a real context would mean that farmers need to adopt pro-environmental practices and would receive a subsidy only in cases where the environmental threshold is attained. This system may be considered too strict and not easily accepted by farmers. An option would be to require farmers to commit to adopt the pro-environmental practice in anticipation and to open contracts only when the threshold would be reached. This situation would alleviate the risk for farmers not to receive either the contract payment or the benefits of the public good. Another option would be to condition only a proportion of the payment to the attainment of the environmental threshold, using a similar mechanism than Kuhfuss et al. (2014). Introducing an element of collective conditionality in presently purely individual AES is an innovation that indeed opens new perspective.

## **CHAPTER 4**

### **CHALLENGES OF ACHIEVING BIODIVERSITY OFFSET OUTCOMES THROUGH AGRI-ENVIRONMENTAL SCHEMES:**

#### **Evidence from an empirical study in Southern France<sup>15</sup>**

### **Introduction**

Biodiversity offsetting (henceforth BO) is increasingly used in environmental policies as a way to halt or slow biodiversity losses caused by the development of infrastructure and urbanization, regarded as one of the major threats on biodiversity due to the species' habitat destruction and fragmentation (Davenport and Davenport, 2006; Quintero and Mathur, 2011). The principle of BO is to achieve a “No Net Loss” (henceforth NNL) of biodiversity by providing ecological gains at least equivalent to residual losses (Bull *et al.*, 2013a). In many countries, as a regulatory requirement, BO is incorporated in a mitigation hierarchy aimed at first avoiding and minimizing residual losses, and then, in a last resort, offsetting residual impacts on biodiversity. BO requirements appeared in environmental legislations of many countries in the 1970s, but they were rarely implemented in practice (McKenney and Kiesecker, 2010; Quétier *et al.*, 2014). Recent regulatory developments and European or international initiatives to achieve NNL of biodiversity have strongly boosted the concept of BO worldwide (Calvet *et al.*, 2015).

Theoretically, the concept of BO offers a way to overcome the classic contradiction between economic development and biodiversity conservation. But in practice, the recent development of this principle is hampered by technical and operational problems that jeopardize its good application mainly due to problems of access to land (Jacob *et al.*, 2015). In European countries, particularly in France where agriculture occupies a large share of non-urban land, the implementation of biodiversity offsets faces difficulties in finding and acquiring land (Etrillard and Pech, 2015). This leads to conflicts, especially with farmers who try to maintain their activity in this fast-moving environment. In this context, implementing BO objectives through the acquisition of agricultural land is often seen as a major challenge to BO

---

<sup>15</sup> This chapter is a modified version of Le Coent, P. and Calvet, C., 2015. Challenges of achieving biodiversity offsetting through agri-environmental schemes: evidence from an empirical study. *Accepted at the Annual Conference of the European Association of Environmental and Resource Economics, Zurich, June 2016*

feasibility. Similar challenges are raised in many countries, where BO lead to restrictions on land uses and access to natural resources by local communities (e.g. Seagle, 2012).

A possible way out of this problematic situation is to make the implementation of BO compatible with agriculture by involving farmers in BO schemes. The idea is to implement biodiversity offsets through voluntary agri-environmental contracts which we call Agri-environmental Biodiversity Offsets Schemes (ABOS). Indeed, compared to land acquisition by a developer, which is commonly used in BO, ABOS only requires a temporary commitment of farmers to changing land use or adapting agricultural practices. It does not require either to cease the farming activity or to transfer land tenure rights from farmers to developers.

As compared to land acquisition, ABOS can therefore represent an opportunity for developers (and regulators) to facilitate the implementation of biodiversity offsets and reduce local conflicts. However, the use of agri-environmental schemes in the context of biodiversity offsets raises specific issues and challenges as compared to land acquisition with regard to NNL targets. A general requirement in BO is that, depending on the level of ecological losses that remain after avoiding and reducing the impact of a project, the developer is set by the State a mandatory target of ecological gains to achieve. The acquisition of land by developers provides long-term control over its use (and agricultural practices) that provides more security for the attainment of this mandatory target. However ABOS, which are voluntary short-term contracts with farmers, do not provide the same level of control.

We argue that the attainment of the BO objective of no net loss of biodiversity through ABOS, requires two conditions. The first one is the *acceptability* by farmers of ABOS contracts proposed by developers. The second one is the *performance* of ABOS contracts in terms of effectiveness. This scheme must indeed induce actual practice or land use change that lead to the expected environmental benefits and these must be sustained over time.

ABOS are a new form AES designed for the implementation of BO. ABOS can also be considered as a kind of Payment for Environmental Service (PES) in which a beneficiary (the developer) pays a provider (the farmer) for an environmental service: the compensation of residual biodiversity loss. These forms of contracts have been extensively studied in the literature, from which lessons can be drawn on the challenges of using ABOS to achieve NNL.

This article sheds light on the opportunities and limits of using ABOS in BO policies by asking the two following research questions:

**Q1.** What are the main determinants that influence the adoption of ABOS by farmers?

**Q2.** What is the performance of ABOS to achieve biodiversity offset objectives?

To address these questions, we conduct an empirical analysis based on a case study located in Southern France. The literature on AES and PES acceptability identifies a diversity of determinants of adoption of contracts. To address our Question 1, we highlight the differences between AES/PES and ABOS and analyse in our empirical analysis whether these differences have an impact on the determinants of contract adoption. To address Question 2, we review the performance challenges faced by agri-environmental contracts in the literature and how they theoretically apply in the context of ABOS. Using a running ABOS programme as a case study, we subsequently analyse the performance of ABOS contracts through the lens of these challenges. While there is an extensive literature on PES and AES programs, to date, there has been no analysis of the use of agri-environmental contracts in the context of biodiversity offsets.

The article is organized into four main sections. First, we present the theoretical background of ABOS's challenges, in terms of acceptability and performance, which allow us to develop two research hypotheses. Then, we present the materials and method used in the empirical analysis to test the hypotheses divided into three subsections: (i) the case-study, (ii) the data collection, and (iii) the data analysis methodology. The third section presents the results of the empirical analysis and discusses these results by examining the opportunities and limits of ABOS in BO policies. The last section finally concludes on policy recommendations for ABOS implementation and research perspectives.

## **1 Background literature and research hypotheses**

### **1.1 Definition of ABOS**

We define ABOS as one or a set of voluntary contract(s) in which a developer pays one or several farmer(s) for changing their practices to provide ecological gains that will serve to offset residual impacts of one or several development projects. Intermediaries can be involved in establishing or managing the relationship between the developer and farmers. The public

administration is typically involved in approving contracts or monitoring expected ecological gains.

BO policies generally involve a third-party transaction in which there are: 1) a buyer of an environmental service, the developer who legally must carry out biodiversity offsets to compensate for the ecological impacts he has caused, 2) a seller of the environmental service, the provider of ecological gains, and 3) a regulator who requires the purchase of offset and controls its implementation (Scemama and Levrel, 2014).

Thus, in this transaction, the farmer is the provider and the seller of the environmental service, and the developer is the beneficiary and the buyer of this environmental service used to comply with his offset requirements. The offset regulator is usually represented by two entities: at national level, by the Government that defines offset rules and requirements, and at local scale, by local authorities whose aim is to enforce environmental legislations (Figure 15).

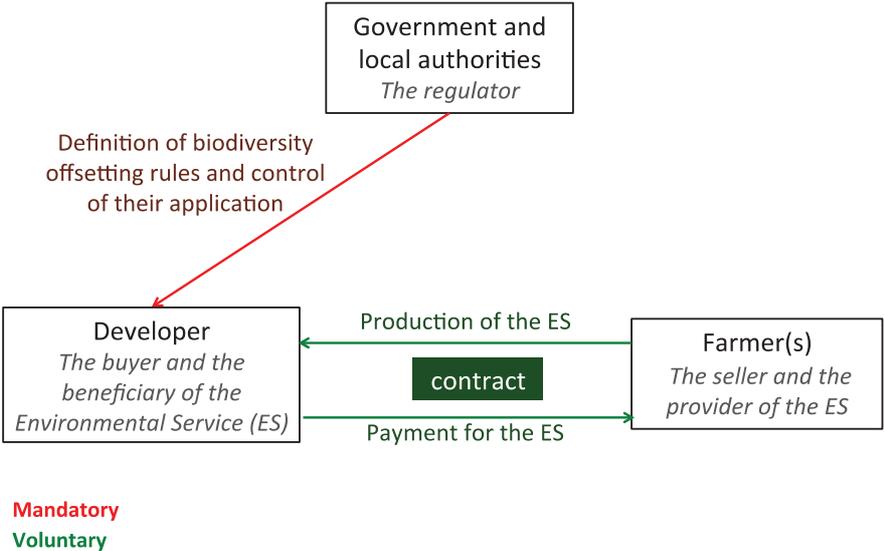


Figure 15: Schematization of Agri-Biodiversity Offset Schemes (ABOS) as a transaction in biodiversity offset policies.

### 1.2 Acceptability of ABOS

The acceptability of ABOS is a key challenge because developers need to find a sufficient number of voluntary farmers and a sufficient amount of agricultural land in order to reach the legally set BO objectives. In addition, considering that contracts are usually short-term

(generally 5 years), the developer must be able to do this several times during the legal duration of its biodiversity offset commitments.

The acceptability by farmers of agri-environmental contracts is well documented in the literature. There is particularly an extensive literature on the determinants of farmers' participation in AES. The acceptability of agri-environmental contracts is influenced by a diversity of determinants that can be classified into four main groups: (1) farmer and farm socio-economic characteristics, (2) contract characteristics, (3) payment level and transaction and implementation costs, and (4) behavioral factors (see details in Appendix 5). Acceptability of ABOS may be influenced by the same determinants but the particularities of this scheme may modulate their importance or even reverse the direction. We present in this section the main determinants that may be particularly important in ABOS adoption:

### **1.2.1 Flexibility**

The flexibility of contract design is among the key factors that facilitate adoption. Contracts that are more likely to be adopted have a shorter duration (Bougherara and Ducos, 2006; Ruto and Garrod, 2009; Louis and Rousset, 2010; Christensen *et al.*, 2011), leave more flexibility to farmers in plot selection (Bougherara and Ducos, 2006; Ruto and Garrod, 2009) and in technical prescriptions (Bougherara and Ducos, 2006; Ruto and Garrod, 2009; Christensen *et al.*, 2011; Kuhfuss *et al.*, 2014). Besides, easiness to withdraw from the contract is also an important criteria in farmers' participation (Christensen *et al.*, 2011). In the CAP, contract design is generally framed by strict legislative and administrative rules limiting farmers' eligibility and leaving little flexibility for the adjustment of contracts' characteristics to specific contexts. BO programmes are generally operated at a limited geographical scale and ABOS are tailor-made according to a specific development project. ABOS are signed between farmers and a developer. Unlike classic AES, ABOS isn't bound by CAP rules that strongly constrain the flexibility of the contracting. Thus, it is expected that ABOS offer a more flexible way in the establishment of the agri-environmental contracts in accordance with offsets commitments. Likewise, due to this flexibility, contract terms will probably be more easily renegotiated in a context of environmental or farm changes. The higher flexibility offered by ABOS will likely have a positive influence on farmers' acceptability.

### **1.2.2 Payment/Costs**

The relationship between costs and payment amounts is a key issue to understand the adoption of agri-environmental contracts (Brotherton, 1991; Drake *et al.*, 1999). It is thus expected to similarly play a fundamental role for ABOS. A particularity, compared to AES, is that payments could theoretically be freely set during the transaction between the developer and farmers. The payment can therefore result from a trade-off between the contracting parties and not be set by public institutions<sup>16</sup>. This agreement can foster the acceptability of ABOS by farmers. In addition, ABOS should generally present less administrative constraints and restrictions than AES, mainly due to simpler procedure and contract terms. This is likely to reduce transaction costs and could be therefore more easily adopted than AES.

### **1.2.3 Social norms**

The role of social norms in the adoption of AES and pro-environmental practices has been recently highlighted (Kuhfuss *et al.*, 2016, chapter 1 and 2 of this thesis). This factor may be an important determinant particularly for the adoption of ABOS and influence farmers' adoption in different ways. On the one hand, BO programmes are linked to the construction of infrastructure that may create local social and economic impacts, and may be associated with expropriation. These factors may create local resistance to any actions associated with the construction project and social pressure not to adopt ABOS. Linked to the opposition to the project itself (or to offsetting as a policy), we anticipate that injunctive social norms may hamper farmers' adoption. On the other hand, the participation of farmers in such a large BO programme can positively influence the enrollment of other farmers in ABOS, through descriptive social norms.

### **1.2.4 Attitude towards the environment**

This factor is one of the prominent factors that have been shown to influence adoption of agri-environmental programmes (Morris and Potter, 1995; Delvaux *et al.*, 1999; Beedell and Rehman, 2000a; Defrancesco *et al.*, 2008; Ducos *et al.*, 2009; Mzoughi, 2011), although this importance is debated (Lamine, 2011). Considering that in ABOS the contract is presented as a transaction between a service buyer and a seller for the compensation of biodiversity damages linked to infrastructure development project, it is likely that ABOS are not

---

<sup>16</sup> It is to be noted that in our case study this difference was not observed because a fixed rate payment was used.

considered as environmental programmes like in AES or PES, and thus do not involve pro-environmental behaviors to the same extent. We anticipate that the attitude towards the environment may have a rather limited importance in ABOS adoption (this question is examined in more details in chapter 5).

### **1.2.5 Trust**

Trust between contracting partners also facilitates participation in AES by reducing transaction costs both before and during the transaction (Ducos and Dupraz, 2007b; Peerlings and Polman, 2009; Ducos *et al.*, 2009; Louis and Rousset, 2010). In Europe, AES are generally struck between farmers and the State within the CAP framework. In the context of BO, developers that offer ABOS to farmers can also come from the private sector. Establishing trust and good relationships among these new actors is therefore a key challenge for the success of BO programmes. The perception of this trust relationship by individual farmer might therefore be an important factor to predict farmers' participation.

## **1.3 Performance of ABOS**

As mentioned previously, the implementation of ABOS must respect mandatory outcomes in terms of ecological gains, which imposes a high level of effectiveness. This means that i) farmers must comply with contract requirements (*compliance*), ii) contracts must result in a real change of land use or agricultural practices (*additionality*), iii) land-use changes must actually lead to desired environmental outcomes (*link between land use and environmental outcomes*) and iv) changes must be sustained over time (*permanence*) (Bull *et al.*, 2013b; Wunder, 2015). We describe below the main challenges that will confront ABOS in relation to these four components.

### **1.3.1 Compliance**

There is an information asymmetry between farmers and the developer in the actual implementation of actions on which they are committed. After the contract has been negotiated, it may be rational for farmers not to respect these terms (moral hazard) if the developer does not invest enough in monitoring compliance or does not impose stringent sanctions (Ferraro, 2008). The implementation of a system of monitoring and control is costly for the developer. He may therefore be tempted to implement a minimal control system that could result in very limited compliance by farmers. Whether or not regulators actually enforce

offset requirements on developers will also be a major driver of developers' behavior in this matter.

### **1.3.2 Additionality**

Additionality means that farmers not only adopt land uses or agricultural practices that are contributing to the targeted outcome but ones that they would not have adopted in the absence of ABOS (Wunder *et al.*, 2008). Some farmers under ABOS may indeed adopt practices that are favourable for a species or habitat, affected by a development project's residual impacts, but that farmers would have adopted anyway. This "windfall effect" should be avoided as much as possible (Chabé-Ferret and Subervie, 2013; Kuhfuss and Subervie, 2015). It does not bring ecological benefits and should not be taken into account in the estimation of NNL achievement. Additionality is a key requirement for BO (Maron *et al.*, 2015). If pre-contract diagnosis is not done properly, selected farmers may even get paid to implement practices that they were already implementing.

**In sum, information asymmetries that are inherently associated with the use of agri-environmental contracts, especially moral hazard and adverse selection, pose specific challenges for the use of this tool in BO, mainly for the issues of compliance and additionality (Ferraro, 2008).**

### **1.3.3 Link between land use and environmental outcomes**

Guaranteeing additionality in terms of actual land-use changes may not be sufficient to attain BO targets. It is indeed necessary that the modification of land use practices leads to the ecological gains targeted in the developer's offset commitments. Several aspects need to be considered here. First, changes in land use and practices included in ABOS requirements must actually lead to environmental benefits, which should be adequately quantified. This requires a solid understanding of the ecology of targeted species or habitats. Second spatial coordination may also be required in order to achieve ecological results. For some species, the spatial configuration of habitats is essential (Forman, 1995) and landscape-level approaches need to be included in contracts to achieve improvements in the conservation status (Goldman *et al.*, 2007).

#### **1.3.4 Permanence**

According to the CAP objectives, AES are supposed to help farmers to sustainably adopt pro-environmental practices. But in practice, many farmers do not maintain their practices when the contract ends (Kuhfuss et al, 2016). In the case of ABOS, the main goal is to avoid net loss of biodiversity. This implies that irreversible losses caused by development projects have to be offset by long-term ecological gains. Likewise, ecological measures usually require significant amounts of time to have significant and visible effects on species. There is therefore a major issue of maintenance of the ecological gains provided by farmers' practices in ABOS. One option could be to offer long-term contracts to farmers (20 years for example, or more) however the literature shows that contracts with long duration are generally not well accepted by farmers (Bougherara and Ducos, 2006; Ruto and Garrod, 2009; Christensen *et al.*, 2011). For instance, this solution has been rejected in our case study in which 5 year contracts have been offered. This permanence issue therefore implies either that the land-use modifications required in contracts is maintained after the term or that new contracts are periodically being signed with farmers for as long as the ecological impact of the infrastructure remains.

## 1.4 Research hypotheses

Based on this literature review, this article explores two hypotheses:

**H1.** Determinants of adoption of ABOS differ from the ones of AES: it is likely that ABOS are more easily adopted due to higher flexibility and limited transaction costs. Social norms and trust may have an important role but that could be either positive or negative. Finally, we anticipate that the attitude towards the environment may not facilitate adoption in ABOS.

**H2.** Information asymmetries associated with agri-environmental contracts limit the performance of ABOS: issues of compliance, additionality and permanence put at risk the achievement of BO objectives through ABOS compared with land acquisition.

## 2 Materials and methods

In this section, we describe the methodology we have used to analyse our case study. We first present the case study and then we define how we analyse the two main issues of acceptability and performance of ABOS.

### 2.1 Presentation of the case study

#### 2.1.1 *The BO project*

We examine the use of ABOS for the implementation of a part of the biodiversity offsets required to compensate the ecological impact of building and operating an 80 km long mixed high-speed railway line between Nîmes and Montpellier, in Southern France. This project, named “Contournement Nîmes-Montpellier” (henceforth CNM project), was initiated in 2000 and in 2012, the construction and maintenance (25 years) was delegated to a private consortium named “Oc’Via”, including the responsibility for the project’s impacts on biodiversity.

Due to the size and location of the CNM project, there are large ecological impacts. In particular, the railway line crosses two Natura 2000 sites designated as Special Protection Areas under the European Habitats Directive as they harbour the largest population of Little Bustard (*Tetrax tetrax* L.) in France (Wolff, 2001a). The little bustard is a flagship species for the CNM project and its stakeholders (including the public administration) due to the significance of the impacted area on its conservation status.

To design and size the offsets required for the CNM project, a specific loss – gain metric was used which combines area and habitat quality to determine “compensation units” (CU), defined as a unit change in habitat-quality on 1 hectare. Little Bustard habitat was assessed on a scale of 0 (unfavourable habitat) to 3 (highly favourable habitat), mainly on the basis of vegetation and agricultural practices. Thus, the destruction of a hectare of highly favourable habitat is a loss of 3 CU while the restoration of a hectare of favourable habitat (rated 2) to highly favourable habitat (rated 3) is a gain of 1 CU. In this example, 3 ha would be needed to offset the loss of 1 ha of Little Bustard habitat. Other combinations are possible depending on habitat quality before and after it is affected by the project or its offsets (destruction, degradation, restoration, etc.). This was considered an innovative approach at the time, given the dominance of area-based ratios in offset practice in France. The full method is described in Oc’Via’s permit application and in Quétier et al. (2015).

The permit granted to Oc’Via requires that they offset the loss of 3279 CUs, meaning that he have to generate an extra 3279 CUs relative to a pre-impact baseline and maintain these until 2037. Most of the CUs are for agricultural habitats (95%), reflecting the types of habitats impacted and the importance given to the Little Bustard. The total amount of land required to achieve this depends on the amount of CU provided by the various land-use practices that are actually put in place and maintained by the developer. It was estimated that around 1668 hectares would have to be made more favourable for the Little Bustards, among which 500 hectares would be acquired and 1168 hectares would be contracted with farmers through ABOS. The required land for this could only be sought in specific areas in and around the Natura 2000 site. The metric and exchange rules were developed only in 2013, several years after a significant number of farmers had been contracted to test the feasibility of ABOS to offset the expected impacts of the CNM project.

### **2.1.2 The ABOS programme**

Oc’Via’s ABOS programme was set-up with the assistance by an *ad hoc* consortium formed by a regional nature conservancy / land trust (*Conservatoire Régional des Espaces Naturels*), a local bird conservation group (*Centre Ornithologique du Gard*), and the Chamber of Agriculture of the Gard area (CA30), a farmers’ institution at the departmental level strongly involved in the technical and administrative support to farmers. This consortium (offset consortium, henceforth) was in charge of implementing, monitoring and enforcing ABOS,

under the supervision of Oc'Via. The annual budget required for the payment of all ABOS is presently of 1564 M€.

The offset consortium defined and proposed a catalogue of 11 agri-environmental measures as possible ABOS contracts. ABOS payments are based on a fixed rate calculated based on average income foregone and additional costs tied to the implementation of the contract, and not negotiated between the parties to the transaction. This agreement, imposed by the local administration and promoted by farmers through the CA30, was set up to avoid excessive competition with other agri-environmental schemes, including AES and the needs of other developers with projects in the area.

In 2010, the offset consortium offered farmers the opportunity to participate in ABOS by sending a letter to 1169 farmers. The programme was opened to farmers for whom farming was their main or secondary activity, with no age restriction, and located in all the municipalities affected by the railway line. Farmers could choose the plots they volunteered to enrol in the program, and the measures they proposed to apply. New calls for proposals were also launched until 2015. In total, the consortium received 124 propositions to participate in the offsetting program, corresponding to 2000 hectares among which they wanted to select 1150 hectares for implementing the ABOS. The consortium set out a selection process to select the best plots to involve in ABOS based on three main criteria: the cost of the measure, the ecological rating of the plots and since 2013 the amount of CU. The ecological rating, which is different from the CU method, is a 1 to 4 score based on the location of plots (areas of known high densities of Little Bustards), plot size ("bigger is better") and the surrounding landscape (e.g. absence of hedges and nearby roads), as Little Bustards prefer large expanses of open habitat unbroken by visual obstacles. There was no clear and precise rule to select plots regarding these criteria; the selection was rather the result of a discussion between the consortium members and the buyer, Oc'Via. Following this selection process, the consortium selected 510 plots managed by 100 farmers and corresponding to 1160 ha.

ABOS contracts have a five-year duration and are payed on a yearly basis. The consortium set up a three-year monitoring and control plan of plots in which they are controlled without preliminary notice once in three years. Enforcement rules are also very flexible. In case of non-compliance with requirements, farmers can receive lower payments, but no sanctions are foreseen. In case of technical problems related to the implementation of the technical specifications, farmers can renegotiate contract terms and even change measures. In worst

cases, farmers can withdraw from the contract even during the contract duration. When the contract ends, farmers can decide to renew it or not on the same plots or to engage other plots. Compared to classic AES contracts, ABOS contracts are therefore much more flexible in terms of eligibility criteria, monitoring and enforcement.

## **2.2 Data collection and data analysis**

The empirical study aims both at analysing determinants of farmers' acceptability and the performance of ABOS implemented for the BO programme of the CNM project. The methods used to analyse our two hypotheses are presented below.

### **2.2.1 *Farmers' acceptability of ABOS***

- **Survey design**

The issue of the acceptability of ABOS was analyzed through a survey carried out in early 2015. The survey questionnaire was designed to determine factors that may explain two variables: i) whether farmers have adopted or not an ABOS, and ii) their intention to adopt an ABOS in the coming years. Survey questions were chosen based on factors that are considered to have an effect on the adoption of ABOS from the literature review on AES (see appendix 1 and section 2.1). The questionnaire covered the following topics: i) farmer and farm socio-economic characteristics, ii) contract flexibility, iii) transaction costs associated with the contract, iv) level of difficulty of the adoption of ABOS prescriptions, v) contract payment and their relation with costs, vi) attitude towards the environment, vii) social norms, viii) trust in the institutions involved in the contract, and ix) attitude towards BO. In most of the questions, farmers had to express their level of agreement with a statement (“strongly disagree”, “disagree”, “agree”, “strongly agree” or “do not know”). We deliberately avoided including a neutral point in our scales in order to prevent farmers from not expressing an opinion. The questionnaire is presented in appendix 6.

The questionnaire was designed in discussion with the stakeholders of the CNM project. It was tested in face-to face interviews with 4 farmers. The questionnaire was subsequently sent to all farmers that had been initially contacted by the CA30 in 2010 when they were searching for voluntary farmers. It was sent to 1169 farmers by postal mail and by e-mail to those for which we had an e-mail address. Farmers were invited to fill the questionnaire on paper and send it back by postal mail or to fill the questionnaire directly online using Limesurvey. We received 39 questionnaires online and 106 questionnaires via postal mail. This 12.4% return

rate is considered good for this type of survey in this field. Among the 145 questionnaires, 24 had to be discarded because they were very incompletely filled. Thus, 121 questionnaires could be analyzed, among which 40 farmers had adopted the ABOS contract (henceforth referred as “adopters”) and 81 had not (henceforth referred as “non-adopters”).

- **Analysis of acceptability**

In our survey, two variables can be analyzed: the actual decision to adopt an ABOS and the intention to adopt one in coming years. The decision to adopt an ABOS was taken from 1 to 5 years before the survey by farmers. The analysis of the determinants of adoption may therefore suffer from a strong endogeneity problem, i.e. it will not be possible to determine whether farmers adopted the ABOS because they were different or if they became different because they have adopted the ABOS. We therefore decided to focus our investigation on the intention of farmers to adopt an ABOS in the future, as we considered this to present less endogeneity issues and because the intention to perform a behavior is considered as one of the main predictors of behavior (Ajzen, 1991). It captures the motivational factors that influence behavior, in other words it is an indication of “how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behavior” - the stronger the intention, the more likely the behavior will be performed (Ajzen, 1991). It was evaluated through the question “Do you intend to sign an ABOS in the coming years?” with the answer options “very unlikely” “rather unlikely” “rather likely” and “very likely” (see appendix 6). This variable however suffers from the limitations and biases of all stated preferences methodologies.

In this study, intention is an ordered variable (henceforth called  $y$ ) coded from 1 to 4, however the difference between the different levels may not be constant. One option would be to turn this scale into a binary variable but it would partially collapse the diversity of intentions among farmers. We therefore decided to analyze this diversity using an ordered logit model (see Chapter 2 section 3.3.2). The description of the explanatory variables used to predict the intention to adopt is provided in appendix 7. Considering that there were missing values, the ordered logit estimation could only be done with 91 individuals out of the 121.

- **Sample description**

Descriptive statistics of our sample are provided in Table 30. Compared to farmers of the Gard province, the sample presents a number of particularities. The sample has a higher proportion of organic farmers, of farms with more land and of cattle and field crop farm and

less horticulture and fruit growing farms. These peculiarities could be due to contracts being offered only in certain areas of the Gard area. The population surveyed is therefore rather the farmers of these areas, but specific data on these farmers were not available. Another possibility is that farmers that had more interest in ABOS were more inclined to respond to the survey. This self-selection may partially bias responses. A way to manage this would have been to first estimate the probability to be part of the sample (Vella, 1998), but we do not have access to individual data of farmers of the area for 2015.

Variable	Modality	N	% of the 121 respondents	Reference (%)	Variable	Modality	N.	% of the 121 respondents	Reference
<b>Gender</b>	Male	99	81.8	73.8	<b>Main farm activity</b>	Field crops	16	13.6	4.5
	Female	22	18.2	26.2		Horticulture	10	8.6	10.9
<b>Age</b>	Less than 40	22	18.2	16.9		Vine growing	61	52.1	53.8
	From 40 to 49	24	19.8	25.0		Orchard	4	3.4	13.2
	From 50 to 59	45	37.2	30.6		Livestock	17	14.6	6.6
	60 or more	30	24.8	27.6	Other	9	7.7	11.0	
<b>Farm size</b>	Less than 20 ha	38	31.4	67.5	<b>Education</b>	Primary	17	14.2	21.5
	From 20 to 50 ha	43	35.5	21.6		Secondary short	27	22.5	33.9
	From 50 to 100 ha	17	14.1	7.0		Secondary long	40	33.3	21.2
	From 100 to 200 ha	17	14.1	2.6		Superior	36	30.0	23.3
	200 ha or more	6	5.0	0.6	<b>Organic agriculture</b>	Yes	26	21.5	12
<b>Importance of farming activity</b>	Principal	100	84.8	No		95	78.5	88	
Secondary	17	14.4							
	Retired	1	0.9						

Table 30: Descriptive statistics of the survey sample compared to the Gard Reference (Source: General Agriculture Census Agreste 2010).

### **2.2.2 ABOS performance**

We analyzed the performance of ABOS in two ways. First, based on the survey, we studied the different challenges highlighted in the literature: compliance, additionality, link between land use and environmental outcomes, and permanence. These issues were addressed through a specific section in the farmers' questionnaire for the farmers enrolled in ABOS programme (see appendix 6). Questions mainly dealt with i) the level of modification of agricultural practices following contract adoption, ii) the criteria used by farmers to select the enrolled plots, and iii) farmers' intentions after the end of contract regarding reenrollment and maintenance of agriculture practices. Data analysis of the enrolled farmers' response is mainly based on descriptive statistics, in order to report their diversity of views. The ambition is therefore not to quantitatively analyze the impact of the programme but rather to identify challenges related to the programme's effectiveness. The issue of links between land use and environmental outcomes were mainly addressed during interviews with implementing partners and through the analysis of the database they provided.

The second approach we used to address ABOS performance is based on the analysis of the plot selection process. Considering that since the beginning (from 2011 to 2015) of the programme, we have information on 908 plots volunteered to be enrolled in the programme and that the consortium selected 510 of these plots, we decided to reconstruct the criteria that intervened in the plot selection through a statistical analysis. We especially wanted to determine the weight of ecological effectiveness (maximization of ecological benefits, in CU, and ecological rating) and economic efficiency for the developer (attainment of BO requirement at minimal cost<sup>17</sup>) in this selection. We collected data from the offset consortium on plots that farmers volunteered to enroll. Information available on these plots is the following: previous crop, ecological rating (see section 2.2), land area offered by the farmer, measure that the farmer proposed to adopt and associated payment. The plot database contains 908 plots that were submitted by farmers for enrolment. Among these, we have information for 829 plots. The remaining plots were rejected before field assessments were conducted.

We ran a logistic regression to estimate the probability of a plot to be selected based on the following explanatory variables: i) land area of the plot (SURF), ii) two effectiveness

---

<sup>17</sup> This criterion can be considered as a measure of efficiency but only on the side of the developer. Analyzing efficiency would require measuring transaction costs for all the parties as well as compliance and opportunity costs for farmers. Socially, payments to farmers can only be considered a transfer (Wunder *et al.*, 2008).

indicators, the ecological rating (ECORATE) and the amount of CU/ha brought by a plot (CU) and iii) an a cost-effectiveness criterion that is the cost per ha for a CU (COSTCU).

### 3 Results and Discussion

In this section, we present and discuss the results in two parts: first we analyze the determinants of farmers' acceptability of ABOS, and second, the performance of ABOS.

#### 3.1 Determinants of farmers' acceptability of ABOS

The intention to adopt an ABOS is characterized by a normal-shaped distribution that is well suited for the use of an ordered logit model (Figure 16).

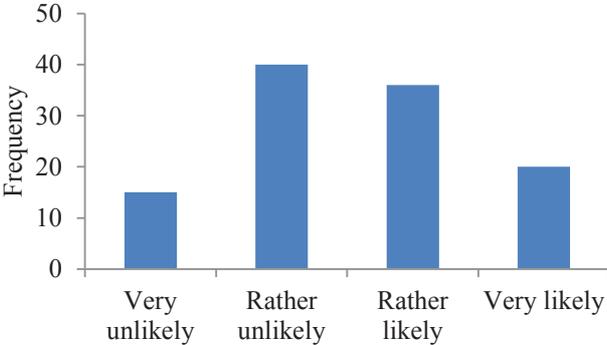


Figure 16: Frequency of farmers according to their intention to adopt an ABOS in the future (Obs: 111).

The results of the ordered logit model are presented in Table 31.

Ordered logit model on intention	Coef.
AGE	-0.42*
EDUC	1.00**
SURF	-0.93
ORGA	-0.10
PROFIT	-1.15**
NEWACTIVITY	1.06*
ACTIVITYRED	2.03**
SUCCESSOR	0.04
ADOPT	1.39**
FLEX	-0.28
TC	-0.11
EASE	0.41**
PAYMENT	1.29**
ENV	-0.70
NATURE	1.01**
RESP	0.31
INSTOPINON	1.20**
NORMDESC	1.14**
TRUST	-0.02
TRUSTDEV	0.53
ATTITBO	0.87*
EFFIC	-1.62**
Cut 1	-1.38
Cut 2	2.17
Cut 3	4.70
Nb. of observations	91
Pseudo R2	0.31
Log Likelihood	-82.1
LR Chi2 (5)	73.17***
Proportionality of odds likelihood ratio test	NS

Table 31: Logit estimation of the intention to adopt an ABOS in the coming years. \*\*and \* refer to significance at the levels of 5% and 10%, respectively.

The results show that **economic motivations** play a crucial role in the intention to adopt ABOS as this is generally the case in AES. Farmers that perceive that it is easy for them to adopt (variable EASE) are more likely to have a high intention to adopt an ABOS in the future. The reasons are that the required practices fit well into their farming system, or because it is an opportunity to them to exploit an unused field plot or yet, or at the extreme, because they already have adopted this practice. In the same line high intenders perceive that the payment level proposed in contracts is interesting (PAYMENT).

Surprisingly, some advantages of ABOS, as compared to classic AES, such as higher flexibility (FLEX) and to a lesser extent lower transaction costs (TC), do not come out as significant determinants of the intention to adopt. This lack of influence may be due to different reasons. First it could simply mean that flexibility is not fundamental for farmers in their choice to enroll. Farmers may have not have been well informed of the advantages of ABOS contracts as compared to AES. This may partially be due a lack of information of farmers on some of the contract advantages.

**Farmers and farm socio-economic factors** also intervene in the adoption. Farmers with higher education (EDUC) have stronger intention to adopt an ABOS. Considering that most ABOS measures require an extensification of agriculture activities, it is not surprising to see that farmers that are in a phase of activity reduction (ACTIVITYRED), such as land area reduction or planning to retire, generally have a stronger intention to adopt an ABOS (as compared to farmers that have not had significant change in the last 5 years). Similarly, farmers that suffer from a low profitability (PROFIT) of their farming activity may consider contract payment as an opportunity to have more regular revenues and are therefore in favor of adopting. Other factors have a less significant influence: younger farmers (AGE) and farmers that are in a new development project (NEWACTIVITY), such as a new production, the conversion to organic farming or farm size increase, are more susceptible to adopt an ABOS. Finally, farmers that had already enrolled in ABOS at the time of the survey are expectedly more likely to enroll in the future.

This study does not only consider the influence of socio-economic factors but also investigates the potential impact of behavioral factors. As anticipated, **social norms** especially seem to intervene in farmers' adoption as emphasized in chapter 1 and 2 of the thesis. Farmers that consider important the enrollment of other farmers (NORMDESC) and farmers that think that the Chamber of Agriculture has a positive opinion on ABOS are more likely to participate (INSTOPINION). This large BO programme has led to the contracting (and acquisition) of a large area of farmland. Because of its size and its impact on local agriculture activities, the BO programme has also raised oppositions from some farmers' cooperatives and councilors. This maybe had a negative influence on the personal attitude of some farmers towards the programme (ATTITBO) and probably on their intention to adopt ABOS. Farmers that have a better general opinion of BO are more likely to adopt an ABOS.

Considering that the developer is a new stakeholder in agriculture contracting and that this type of scheme was new in the area, it was anticipated that trust variables (TRUST and TRUSTDEV) would play a significant role in adoption. However, it does not appear to be the case. As shown in psychology literature, peer influence is recurrently highlighted in empirical studies about farmer behavior (e.g. Burton, 2004). So, we think that the use by the developer of an offset consortium in which the CA30 had a strong involvement has limited the effect of this variable on the intention to enroll.

As we expected, the role of the attitude towards the environment (ENV) and the feeling of responsibility by farmers for the protection of threatened bird species (RESP) do not come out as significant determinant of the intention to adopt ABOS. The only variable that is positively linked with adoption is the fact to be member of an environmental association or to carry out nature activities, such as hiking, hunting or fishing (NATURE). This relatively low influence of environment susceptibility indicators may be due to the fact that farmers predominantly responded positively to environmental sensitivity questions: 89% agreed that protecting threatened bird species is a priority for the area and 85% that it is their responsibility to protect them. A more discriminating indicator of environmental susceptibility may have been necessary. Another interpretation could be that for ABOS, in contrast to AES, adopting a contract may be strictly considered as a service transaction by farmers that therefore mobilize lower environmental considerations.

Finally, farmers that perceive that the programme will lead to an effective protection of threatened bird species are less likely to have a strong intention to adopt. This result is the only effect that goes against expectations. A possible interpretation may be that farmers who have the most positive opinion on the results of the programme may consider their future participation superfluous.

To conclude, this analysis of the determinants of the intention to participate in ABOS highlights the role of traditional factors known from studies of AES: high intenders tend to have a low profitability, to be more educated, to positively judge payments, to consider the implementation of ABOS requirements easy on their farm or to have already adopted a similar contract. Factors that differentiate ABOS and AES such as the perception of the flexibility of the contracts and transaction costs didn't have the expected influence. Behavioral factors such as the perception of social norms and the personal attitude towards BO, however, are key factors in the adoption of ABOS. However, the feeling of trust in

contracting institutions does not seem to be critical. Finally, the susceptibility to environmental issues does not seem to be a key factor in farmers’ adoption of ABOS.

**3.2 Performance of ABOS**

In this section, we analyse the performance of ABOS in two different ways. We first present the results of the survey carried out with the enrolled farmers in ABOS based on the analysis of additionality, compliance, link between land use and environmental outcomes and permanence. Second, we analyse the influence of the plot selection process on the effectiveness and efficiency of the BO programme.

**3.2.1 Analysis of the survey of farmers engaged in the AES programme**

- **Additionality and compliance**

In this section, we analyze questions that bring information on the magnitude of the change undertaken by farmers following their adoption of the contract. Replies to the question “How would you qualify the magnitude of the change of agricultural practice that you’ve had to undertake following your enrollment in the ABOS” are presented in Table 32.

<b>Intensity of practice change following ABOS adoption</b>	<b>% of respondents</b>
No change	19%
Low change	39%
Medium change	36%
High change	6%

Table 32: Intensity of practice change following ABOS adoption. (N=36)

The results show that 58% of the enrolled farmers have declared not having made changes (19%) or low modifications (39%) to their practices following the adoption of the ABOS. In light of these results, the real additional effect of these ABOS on biodiversity is questionable. We can suppose that the changes declared by respondents did not produce the desired gains in habitat quality for the Little Bustard. This very low level of practice change for a majority of farmers can be due to the fact that farmers that were selected already implemented the practice before they enrolled (additionality issue) or can be due to the fact that farmers did not follow the requirements of the contract (compliance issue). Monitoring by the offset consortium in 2013 indicated only 75% conformity with the requirements of the ABOS, including 10% involuntary technical difficulties and 15% deliberate non-compliance (CEN-LR *et al.*, 2013). These results are confirmed by the responses to the question “how did you select the plot that you submitted for enrollment”, which are presented in Table 33.

<b>Farmers' plot selection criteria</b>	<b>% of respondents</b>
Plots that seemed ecologically relevant	61%
Plots on which it seemed easy to implement the requires	61%
Plots on which I was already implementing the practices	78%
Plots with low productivity	2%
Plots far away from the farm	5%

Table 33: Criteria quoted by farmers for farmers for the selection of plots they offered

These results confirm that a high proportion of farmers did not implement much change in their plots. Indeed, 78% of the adopting farmers indicated that they were already implementing the required practices on the plots before they enrolled them. Although qualitative, these results confirm that additionality and compliance issues that we theoretically emphasized in section 2.2 are indeed challenges for the use of ABOS to achieve BO objectives. For developers to deliver the ecological gains required to achieve the NNL objectives set by regulators, it is crucial that these challenges be addressed in future ABOS programmes. The analysis of the plot selection process that we conduct in the following section 3.2.2 sheds further light on this point.

- **Link between land use change and the provision of ecological gains**

As a condition to its permit, the developer, Oc'Via, had to generate 3079 CU by April 2015. This was achieved with 500 ha of land directly acquired by the developer (generating 1015 CU + a bonus of 1 CU/ha for land it had under direct control through acquisition) and 1168 ha through ABOS contracts (generating 1550 UC).

However, this does not guarantee the attainment of ecological objectives in terms of conservation of the Little Bustard in and around the Natura 2000 site (Devoucoux, 2014). Indeed, it is difficult to estimate whether the adoption of ABOS has actually led to an increase of the population of birds on enrolled plots and if it has compensated losses caused by the CNM project. Preliminary results show that the local landscape is reaching carrying capacity (Devoucoux, 2014) which makes it all the more important for offsets to maintain that carrying capacity as the railway line cuts through the Natura 2000 site. Simply displacing individual birds to favorable but unoccupied habitats won't be possible in those circumstances. The metric and exchange rules used to design and size the offset requirements for Oc'Via focus are suited to this challenge (with a focus on increases in habitat favorability per unit area) but remain based in expert judgement and the quantitative relationship between favorability and

bird densities remains uncertain. It is premature to fully evaluate the actual ecological gains linked to ABOS in our case study.

Another way to analyze the link between land use change and ecological is to compare the two ecological indicators used in the process. Specifically, the ecological rating takes into account local ecological characteristics (distance to a road or an urban area, presence or absence of population of little bustard before the enrollment, distance to other plots with favorable practices, presence or absence of hedges, plot area) while CUs is a broad indicators that focuses on land-use change within the plot.

Our analysis of the plot selection database demonstrates the loose relationship between CU and ecological rating (Table 34). Somewhat surprisingly, plots with the lowest ecological rating do not lead to lower amounts of CU than plots with higher ratings.

Ecological rating	Number of plots	Average CU/ha
1	37	1.53
2	243	1.20
3	503	1.27
4	46	1.64

Table 34: Average CU/ha benefits for the different level of ecological rating.

Depending on the final plot selection, different levels of final ecological favorability can therefore be obtained with the same level of CUs. This simple table questions the idea of setting BO objectives on a “simple” generalized metric, such as CU. Although this metric can help determining the size of the BO efforts, it should be assorted with requirement on how to maximize ecological gains at the plot level.

**- Permanence**

Considering that contracts are signed for a period of 5 years and that the BO programme is legally supposed to ensure ecological benefits for a period of 25 years, the durability of benefits obtained through ABOS is a key issue. Two main dimensions of permanence are analyzed here: 1) whether farmers plan to sign a new contract after the end of their current contract (Table 35), and 2) what they plan to do in case their current contract ends and is not renewed (Table 36).

<b>Farmers' intentions after their current contract ends regarding the signature of a new contract</b>	<b>% of respondents</b>
Stop ABOS	6%
Sign again for the same area	56%
Sign again for a smaller area	12%
Sign again for a larger area	26%

Table 35: Farmers' intentions after their current contract ends regarding the signature of a new ABOS contract (N=34)

<b>Farmers' intentions regarding their agricultural practices in the absence of ABOS</b>	<b>% of respondents</b>
Abandon the practices	36%
Maintain the practices	36%
Adopt other favorable practices	24%

Table 36: Farmers' intentions regarding their agricultural practices in the absence of ABOS (N=33)

Farmers generally seem to be satisfied with the contracts and 92% of the farmers plan to maintain or increase the land area under contract after their current contract ends. Thus, maintaining farmers under contract, during the period in which the developer needs to ensure offsets are effective is critical but seems achievable. However, only 36% of farmers would maintain the practices included in the requirement of their contract in the absence of ABOS. This result raises the issue of the permanence of the ecological benefits obtained through ABOS after the legal period of 25 years.

### ***3.2.2 Analysis of the plot selection process***

When ABOS was launched in 2011 and until 2015, the amount of land that farmers volunteered to enroll was superior to the programme's target. To avoid competition with existing AES, a fixed price payment was chosen and plots were selected based on a multicriteria approach. This approach included the ecological rating and criteria that affect the cost of the programme for developers such as the relationship between the level of payment and the CU/ha<sup>18</sup>. The interests of the offset consortium and the developer were most likely not fully aligned and our results show which criteria prevailed in the plot selection process (Table 37).

<sup>18</sup> The CU criteria was not used in the contractual phase in 2011 but was used in latter contractual phases. We nevertheless reconstruct the weight of these criteria throughout the selection process.

Logit model estimation plot selection	Coef.	Marginal effects
SURF	-0.08***	-0.0143***
ECORATE (Ref=1)		
2	0.093	0.1976
3	0.902**	0.1756**
4	2.849***	0.3962***
CU	0.261	0.0458
COSTCU	-0.002***	-0.0004***
<hr/>		
Nb. of observations	829	
Pseudo R2	0.17	
Log Likelihood	-437.7	
LR Chi2 (5)	184.88***	
Percentage of adequate predictions	76.60%	

Table 37: Logit estimation of the plot selection choice  
\*\*\* and \*\* refer to significance at the levels of 1% and 5%, respectively.

As expected, the ecological rating strongly intervened in the selection choice: plots rated at 3 or 4 had a significantly higher probability to be selected. However, we also show that the bigger the plot offered by a farmer the less chance it had to be end up being selected. This is unexpected considering that bigger plots were *a priori* more interesting from an ecological point of view and size was one of the criteria used in the selection process.

The amount of CU that a plot yielded does not have a significant effect on the probability of a plot to be selected. Cost-effectiveness (the cost to yield a CU), however, did have a significant effect: plots that generated costlier CU had a lower probability of being selected.

Using marginal effects, we can estimate that a plot that has the highest Euro/CU rate (1000€/CU) has 41.5% less chance to be selected than the plot that has the lowest rate (70 €/CU), while the plot that has an ecological rating of 4 has 45.8% more chance to be selected than a plot with an ecological rating of 1. Both criteria had similar effects on plot selection process. Furthermore, budget simulations show that, for the same CU target, if only the plots with highest ecological rating (4) had been chosen, the budget would have increased by 32%, while the budget would have decreased by 41% if only the cost-efficiency criteria would had been used.

From a purely economic standpoint, minimizing the cost of the programme should be the objective, as long as the CU target is achieved. In this case, the option of selecting plots based on cost-effectiveness, as would be done in an agri-environmental auction, would be the best option. On the other hand, considering the limits of CU as an ecological effectiveness indicator and reserves that we highlighted on additionality and compliance, a safe option to have more chance to reach NNL objectives would be to maximize the ecological favorability of selected plots. Indeed, in both cases the legal target in CU would have been attained, however the habitat created in the latter case would be much more favorable for the Little Bustard. The solution that was found is one that partially satisfies all parties but does not reflect a clear-cut political decision between minimizing costs and ensuring the attainment of BO objectives.

#### **4 Conclusion and Policy implications**

The main objective of this article was to analyze the opportunities and challenges of using agri-environmental schemes in biodiversity offset implementation. Compared to land acquisition and management, ABOS present a number of advantages. First, it may be better accepted by farmers as it reduces pressure on the land market and represents an opportunity of additional revenue. Second, the use of ABOS reduces upfront costs for the developer, especially in context where the price of land is high. Third, the use of contracts allows greater flexibility and better adaptability of the offsetting system in case of environmental or institutional changes.

The main challenge of ABOS, as compared to land acquisition, is that the control of land use passes through a contract between the developer and farmers and is not under direct management. Yet, regulators require that developers achieve set targets of ecological gains, tied to the “No Net Loss” principle. Achieving BO objectives through ABOS therefore requires that i) a sufficient number of farmers accept to enrol in the programme and ii) that the contracts and their implementation are effective. However, information asymmetries that are inherently associated with agri-environmental contracts pose specific challenges for the use of this tool in BO, mainly in terms of compliance and additionality. In this paper, we identified the magnitude of these challenges through an empirical analysis of the ABOS programme put in place for a new railway line currently being built in Southern France. A survey of 145 farmers among those enrolled in the programme gave us insights into the determinants of their participation and into the effectiveness of the programme.

Our results suggest that the main determinants of acceptability are: i) classic economic factors (farmers with least compliance and opportunity costs, as well as farms in economic difficulty, are more likely to adopt), and ii) moral and social norms (the personal opinion on BO, the importance given to others' decision and the feeling that this decision is accepted by farmers' representatives). This result confirms the importance of norms in the adoption of AES in general (See chapter 1 and 2 of the thesis). Norms is an aspect that should be particularly considered in the implementation of ABOS. BO are a relatively new policy instrument that is debated amongst farmers, farmer unions and politicians. Improving the general opinion on BO through continuous engagement by public authorities and environmental groups could strengthen and broaden support by other members of rural communities, which in turn may be an important element of success of future ABOS programmes.

The analysis of ABOS effectiveness also reveals issues related to additionality. Additionality issues essentially stem from an adverse selection issue, which leads to the identification of farmers that cannot produce the environmental benefit in the most cost-effective way. Ferraro (2008) proposes 3 solutions to overcome this problem: (1) acquire information on the environmental benefits that farmers can potentially offer and select them on this basis; (2) offer to farmers a menu of screening contracts; and (3) allocate contracts through agri-environmental auctions. In our case study, the first solution was privileged through a plot selection process that probably improved the additionality of the programme. However, due to the fixed-payment system calculated on foregone profits and additional costs, the payment system does not allow the payment of farmers according to the environmental, or BO, service they provide. Considering that there was a greater offer of plots by farmers than the final demand from the developer, the selection of plots and farmers could have been made through an auction mechanism (e.g. Latacz-Lohmann and Van der Hamsvoort, 1997). A system with differentiated payment such as an auctioning mechanism would probably have improved additionality. Indeed, by paying less for contracts to low opportunity cost landowners, who are the most likely to adopt the practice even in the absence of a programme, the developer saves money to contract with higher opportunity cost landowners, who are more likely to participate and generate the desired biodiversity gains (Ferraro, 2008). Undertaking a quantitative impact evaluation would be necessary to precisely quantify the magnitude of this problem.

The analysis of the effectiveness of contracts also emphasized relatively high rates of non-compliance. Dealing with the issue of non-compliance would require a modification of the

monitoring and enforcement system. Different theoretical contributions have studied how to determine the trade-off between environmental benefits, the cost of monitoring and the level of penalty. This trade-off essentially depends on farmers' risk aversion, with less monitoring efforts needed for risk averse farmers than for risk neutral ones when the level of sanctions is held constant (Latacz-Lohmann and Webster, 1998; Choe and Fraser, 1999; Ozanne *et al.*, 2001; Fraser, 2002). In our case study, the high rate of non-compliance suggests that the level of penalty and the intensity of monitoring may not be sufficient. This could be due to the same consortium being in charge of design, implementation, monitoring and enforcement of the programme. It would therefore be necessary to raise monitoring efforts and strengthen enforcement to ensure compliance, possibly through third-party auditing. Another option that is frequently proposed in the literature is to shift from action-based contracts to result-rented contracts. This approach has been implemented in a number of countries, including for the protection of bird species (Burton and Schwarz, 2013). This approach would help solve the compliance issue but it shifts the risks of failure from the developer to farmers (or the offset consortium). This risk transfer is generally not well accepted by farmers (Burton and Schwarz, 2013).

In previous recommendations on compliance and additionality, we refer to research results in which agri-environmental contracts are modelled as a simple principal-agent model between farmers and the State. However, in our case, there is a principal-agent relationship between the developer and farmers, in the framework of ABOS, but there is also one between the regulator and the developer. In order to ensure that the developer actually cares about issues of additionality and non-compliance, the regulator must ensure that the incentives of the developer are aligned with the common society's interest. For example, the developer objective may not be to find a balance between farmer's compliance and monitoring costs but only to minimize the costs of monitoring. A monitoring and sanction system should therefore also be implemented by the State to ensure that developers adequately implement ABOS contracts. This idea of a cascade of principal-agent relationship for the implementation of BO through agri-environmental contracts, and the need to determine appropriate incentives for farmers and developers, could be the object of future theoretical developments.

Ensuring that additional land-use changes obtained thanks to ABOS actually lead to the required ecological gains is another important challenge. Knowledge is often limited and ecological equivalence and targets cannot be precisely set. The use of Compensation Units, based on the change of land use and practice modification, as in our case study, is an

interesting approach to size BO requirements. However, because it does not take into account the local favorability (proximity to roads, presence of other groups of the same species, proximity of other favorable habitats), targets in terms of CU can be attained with very different levels of favorability of the resulting habitats and therefore different levels ecological gains. In the CNM case study, the selection of plots to be included in ABOS was based both on a local ecological indicator and the costs for the developer of the CUs this plot would yield. This equilibrium was found, probably due to the diversity of interest of the institutions involved in the plot selection process. Considering the uncertainties that still weigh on the sizing of biodiversity offsets, relying exclusively on metric approaches such as CUs would be hazardous. It is therefore important that the State and/or ecological organizations are involved, in order to ensure ecological interests are taken into account to maximize the impact of the BO programmes.

Finally, our results show that although farmers may be ready to maintain their contractual agreements in the next period, very few would maintain their practice in the absence of financial support. In our case study, BO objectives are set for a period of 25 years, after which there is no guarantee from any party that offset measures will be sustained, although the loss of habitat is largely irreversible. Whilst it may be unreasonable to expect developers to finance compensation measure *ad infinitum*, such arrangements would place a considerable burden on public finances if every offset were to fall back on public funding once private sector obligation are through. The long-term financing of offsets is yet to be addressed in France.

This chapter highlights some of the key issues associated with the use of AES for a new application: the implementation of BO. In addition to the points raised in this chapter, one important difference between biodiversity AES and ABOS is the fact that their aim is different: one is the conservation of diversity and the other is the compensation of biodiversity. In the following chapter, our aim is to determine if, for behavioral reasons, this may have an impact on farmers' willingness to participate in ABOS.

## **CHAPTER 5**

### **COMPENSATING ENVIRONMENTAL LOSSES VERSUS CREATING ENVIRONMENTAL GAINS**

#### **Implications for biodiversity offsets and AES<sup>19</sup>**

##### **Introduction**

Agri-environmental Biodiversity Offset Schemes (ABOS) are very similar to existing AES aiming at biodiversity conservation on farmland. Indeed it is often the case that the habitats that must be created to offset biodiversity losses are also habitats that the European Union seeks to preserve in protected areas. Therefore ABOS compensation contracts often display exactly the same technical specifications as equivalent AES conservation contracts. However ABOS and AES contracts, although similar in their design, differ in two specific features which do not change monetary cost-benefit ratio for farmers but may have an impact on their subjective perceptions of the contracts and therefore on their willingness to participate. First, contract purposes are framed differently: ABOS explicitly aim at compensating biodiversity damages generated by a development project while AES are advertised as contracts for the conservation or the improvement of biodiversity. Second, ABOS are mainly offered and funded by the private sector while AES are traditionally designed and financed by the public sector (usually at national or European levels).

The objective of this article is to determine whether these differences, all other things considered equal, have an impact on farmers' participation in ABOS. Standard economic theory predicts that farmers should be indifferent between the two types of contracts since expected monetary costs and benefits are identical under both types of contracts. However, insights from behavioral economics and previous empirical findings on farmers' motivations when joining AES (such as preferences for the environment or aversion to loss) indicate that the contract framing may change farmers' willingness to accept. A program financed by public money and presented as a contribution to environmental improvement can be perceived

---

<sup>19</sup> This chapter is a modified version of Le Coent P., Preget R. and Thoyer S., 2016. Compensating environmental losses versus creating environmental gains. Implications for biodiversity offsets and agri-environmental contracts *presented at 90th Annual Conference of the Agricultural Economics Society, University of Warwick, England, 2016*

differently from a program financed by a “polluter” compelled by law to create environmental services in order to compensate the damages he has created elsewhere.

Since offsetting needs are increasing rapidly, it is crucial for public authorities to anticipate whether ABOS is a relevant mechanism to help developers to fulfill their legal obligation in terms of offset volumes. Developers also need to measure the acceptability of such mechanism, *i.e.* the impact of the specific features of ABOS on farmers’ willingness to participate and on the payment they will request to join the scheme and provide adequate offsets. Finally, it should be underlined that ABOS and AES aiming at biodiversity conservation are likely to be activated in the same protected areas. There is therefore a risk of competition between these two types of contracts. If ABOS are preferred by farmers, this may lead to their reduced participation in conservation AES, leading to a substitution of conservation efforts by compensation efforts, and possibly entailing reduced additionality. Understanding the relative preference of farmers for the characteristics of these two contracts will therefore also help to estimate this risk.

Literature on biodiversity offsets has primarily focused on issues related to the calculation of biodiversity equivalence and uncertainties (Bull *et al.*, 2013a; Quétier *et al.*, 2014). Economic contributions are more recent and concern mostly the evaluation of offset efficiency for various program designs (McKenney and Kiesecker, 2010). Our contribution focuses on the acceptability of biodiversity offset contracts as compared to classical biodiversity conservation agri-environmental contracts. Using a choice experiment method, it quantifies farmers’ relative preferences for conservation contracts versus compensation contracts.

The survey has been conducted concomitantly with the survey described in chapter 4. We decided to carry out the choice experiment in the area where the CNM project was implemented because participants had been already exposed to both ABOS contracts and AES for biodiversity conservation and are therefore well acquainted with those two types of programmes.

Section 1 provides a literature review of the behavioral factors that may influence farmers’ acceptability of agri-environmental contracts aiming at biodiversity offset. Section 2 describes the choice modeling methodology used in this research. Section 3 presents the results in terms of preference for the alternative contracts proposed and factors that may explain these preferences. Section 4 discusses these results and concludes with policy implications.

# 1 Literature review

In order to investigate the factors that may influence the preference for one contract or the other, we have conducted a choice experiment (described in details in section 2), in which the two contracts were presented as follows:

- Conservation contracts: they are **proposed and funded by the public sector** with the objective to **create or maintain** favorable habitats for threatened species (AES)
- Compensation contracts: they are **proposed and paid by a private company** that **must, because of the construction of an infrastructure, compensate the degradation of favorable habitats** for threatened species by recreating elsewhere on the territory equivalent favorable habitats (ABOS).

The differences between the two contracts are threefold: (i) the overall purpose of the contract (compensation of a biodiversity loss versus conservation or creation of a biodiversity gain), (ii) the identification of responsibility for biodiversity damages (a private developer versus no clearly specified responsibility), and (iii) the nature of the principal in the contract relationship (private or public)

## 1.1 Purpose difference: compensation vs conservation

The first main difference lies in the contract purpose: compensating the degradation of habitats *vs* creating or maintaining habitats. It can be considered a goal framing issue (Levin *et al.*, 1998). Goal framing is about presenting the consequence of a choice or an action either as positive (it provides a benefit or gain) or as negative (it prevents or avoids a loss). Goal framing is thus associated with a change in the reference point of a decision. Several experimental studies examine the effect of goal framing in the context of public good provision (Brewer and Kramer, 1986; Fleishman, 1988; Andreoni, 1995; Sonnemans *et al.*, 1998). In the positive frame subjects *give* to a public good fund, whereas in the negative frame subjects *take* from the public good fund to purchase private goods. There is no clear conclusion from this literature on which frame, positive or negative, has the greater persuasive impact on contributions.

Relying on this literature, Blasch (2015) considers a different experiment in which contribution to a public good is framed as the neutralization of a negative externality. She positions her experiment in the context of voluntary contributions to climate change

mitigation. She compares hypothetical donation choices made by respondents in an on-line survey when they are framed as “positive donation” (act of ‘doing good’ by donating money to a climate change mitigation project) or as “negative offset” (act of ‘undoing harm’ by donating to a carbon offset program neutralizing one’s own CO<sub>2</sub> emission). She also emphasizes the importance of the reference point. In the negative framing, the reference point is in the loss domain and the contribution brings the public good provision level back to the initial level, whereas in the positive framing, the contribution pushes the public good provision level into the gain domain. Relying on the theory of impure altruism (Andreoni, 1990), Blash assumes that contributors to the public good derive a positive utility associated with “undoing harm” in the loss domain because their cold prickle is reduced, and with “doing good” in the domain of gains because they experience warm glow. Combined with elements of the loss aversion theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1991), which states that the utility function does not display the same concavity in the gain and loss domains, she predicts that individuals should contribute more in the negative framing unless they are gain-seeking in terms of altruistic utility.

The same reasoning could be applied to the conservation/compensation contract issue but there are other differences. First, the compensation contract specifies that efforts are undertaken to compensate a biodiversity degradation which has already taken place. This might be a non-neutral information from a behavioral viewpoint. Gregory et al (1993) investigate the effect of “past states” of the environment on the willingness to support mitigation policies. They conduct an experiment in which students are asked to evaluate the desirability of an environmental improvement in several domains. These environmental improvements are either framed as improvements of the current situation or as restoration after a degradation (although they do not specify responsibilities). Results reveal that respondents prefer to support the restoration to the initial state of a previous environmental loss rather than a net environmental improvement. Gregory et al. also invoke the prospect theory and loss aversion to explain the higher willingness of respondents to support an environmental improvement policy. Restoring the environment as it was in the past, i.e. compensating a loss, provides more utility especially for loss averse individuals, than in the environmental gain domain.

## 1.2 Responsibility for the loss

In Blasch's paper, the person who takes the decision to compensate is directly responsible for the degradation of the environment in the negative framing since she is the CO<sub>2</sub> emitter in the first place. What happens when the degradation of the environment is due to a third party, such as a developer in the case of biodiversity offsets?

Some studies investigate the impact of the cause of threats to the environment. However, they usually focus on how human versus natural causes of environmental degradation influence the willingness to pay for mitigation interventions (Kahneman *et al.*, 1993; Bulte *et al.*, 2005). They find that when human action is the cause of an environmental problem, the willingness to pay to repair damages is higher. They argue that this is due to an "outrage effect" for human-caused environmental issues. Walker *et al.* (1999) study the same type of issue by comparing *inter alia* the willingness to accept to feel compensated for the removal of a street tree, either due to a disease (natural cause) or to the widening of a street (human cause). Unlike previously cited studies, they find a significantly higher WTA to compensate a human caused tree removal than for the natural caused one. They consider that the feeling of moral responsibility may play an important role in the WTA evaluation for human caused environmental issues. When looking at human-caused issues, the identity of person or group who is morally responsible for an environmental degradation has a strong effect on people's preferences for a mitigation policy. This result is however not confirmed by Bulte *et al.* (2005) who do not find any difference between the willingness to pay for the protection of seals threatened by either global warming (common responsibility) or by oil drilling activities (specific responsibility).

The preference for biodiversity offset contracts versus biodiversity conservation contracts may therefore be influenced by two conflicting factors. On the one hand, the compensation could be considered as the restoration of a loss of biodiversity and should therefore be preferred, due to loss aversion. On the other hand, in the compensation frame, the developer is clearly responsible for the environmental degradation and farmers may want to reduce their willingness to contribute to the realization of such contracts, in order not to feel / be considered accomplice of this degradation.

### **1.3 Environmental attitude**

This question also relates to the role of attitude towards the environment in the adoption of agri-environmental contracts. Beedel and Rehman (2000a) show that farmers belonging to an environmental association are more likely to adopt pro-environmental practices. Mzoughi (2011) emphasizes that the motivation “showing one’s environmental concern to others” is important for organic farmers and farmers adopting integrated pest management practices as compared to conventional farmers. The attitude towards the environment in AES seems to play a greater role for measures requiring more efforts from farmers (Delvaux *et al.*, 1999; Vanslebrouck *et al.*, 2002b). We assume that the effect of the susceptibility to the environment depends on the expected outcome of the policies. In our case study, the end level of biodiversity will be unchanged with ABOS and improved with AES. Considering that farmers who are sensitive to environmental issues are those who value the most the benefits of an environmental public good, we can thus make the hypothesis that they will prefer conservation contracts over compensation contracts.

### **1.4 Trust in contracting partners**

Trust between contracting partners is considered a major factor in the adoption of AES. The perception of a trustworthy relationship facilitates participation by reducing transaction costs both before and during the transaction (Ducos and Dupraz, 2007a; Ducos *et al.*, 2009; Peerlings and Polman, 2009; Louis and Rousset, 2010). In Europe, AES are generally signed between farmers and state authorities under the Common agricultural Policy (CAP) framework. They are well-known contracts. In the context of compensation contracts, developers are new stakeholders, generally little known in the farming sector. The fact that they belong to the private sector may be perceived positively, as a source of efficiency and flexibility compared to the bureaucratic red-tape and rigidities, but it may also raise suspicions on their capacity to guarantee payments over the duration of the contract. It is also likely to play a role in farmers’ preference for compensation or conservation contracts.

## 2 Method

### 2.1 Choice experiment approach and model specification

In order to determine the influence of ABOS contract characteristics on farmers' participation, we carry out a choice experiment (CE). The CE approach is based on Lancaster's theory of consumer choice which establishes that choices are determined by the utility that is derived from the attributes of a good, rather than from the good per se (Lancaster, 1966). The econometric modeling is based on the random utility theory, which assumes that utility is composed of a deterministic component, which can be estimated based on observed choices and the characteristics of the alternative assuming that individuals maximize utility, and a stochastic error component (McFadden, 1974).

The conditional logit is the most commonly used model to analyze CE. It however requires two strong assumptions: the Independence of Irrelevant Alternatives (IIA) and the homogeneity of preferences among respondents (Hausman and McFadden, 1984). The IIA supposes that the relative odds of an alternative being chosen over another should be independent of the presence or absence of unchosen third alternatives (McFadden, 1974). These conditions are likely to be violated in our case since we have introduced an opt-out alternative in each choice card. In addition, it is likely that behavioral factors mentioned in the literature review affect farmers' preferences for compensation or conservation contracts in a heterogeneous manner. The heterogeneity of preferences is therefore of particular interest in this study. For these reasons, we have privileged the use of the mixed logit or random parameter model to analyse our data. It allows preferences to vary randomly and continuously across individuals and does not require the IIA assumption (McFadden and Train, 2000).

In the mixed logit model, the utility that respondent  $n$  derives from choosing alternative  $i$ , in choice situation  $C_t (t = 1, \dots, T)$  is given by:

$$U_{int} = \beta_n X_{int} + \varepsilon_{int}$$

where  $X_{int}$  are the attributes of alternative  $i$  and the coefficient vector  $\beta_n$ , represents the vector of individual tastes.

Individual  $n$  will choose alternative  $i$  in choice situation  $t$  ( $A_{int} = 1$ ) among all other alternatives  $j$ , if this alternative gives him the highest utility in this choice situation:

$$A_{int} = \begin{cases} 1 & \text{if } U_{int} > U_{jnt}, \quad \forall j \in C_t, j \neq i \\ 0 & \text{otherwise} \end{cases}$$

Assuming that  $\varepsilon_{int}$  follows an extreme value distribution, the probability that  $A_{int} = 1$  conditional on vector  $\beta_n$  is a standard conditional logit (McFadden 1974).

$$P(A_{int} = 1 | \beta_n) = \frac{\exp(X'_{int}\beta_n)}{\sum_{j \in C} \exp(X'_{jnt}\beta_n)}$$

The researcher does not observe  $\beta_n$ , only its density  $f(\beta)$  is assumed to be known. The probability of observing the sequence of T choices:

$$P(A_{in1} = 1, \dots, A_{inT} = 1) = \int \left( \prod_{t=1}^T \frac{\exp(X'_{int}\beta)}{\sum_{j \in C} \exp(X'_{jnt}\beta)} \right) f(\beta) d\beta$$

where  $f(\beta)$  can be specified to be normal or lognormal:  $\beta \sim N(b, s)$  or  $\ln \beta \sim N(b, s)$  (McFadden and Train, 2000). The parameters  $b$  and  $s$  are respectively the mean and the variance of these distributions and are to be estimated by simulation.

We analyze the heterogeneity of preferences by interacting individual specific behavioral characteristics with attribute levels.

## 2.2 Contract attributes

There is a rapidly growing literature using choice experiments to measure farmers' preferences for various technical specifications of agri-environmental contracts. Typically, they study two types of attributes: those having a direct effect on farmers' compliance costs (levels and types of environmental efforts) and those related to contract design (length of contract, contract cancellation options, contract flexibility etc.). Our experiment introduces a novel attribute, which can capture farmers' preferences for the ultimate purpose of the contract. Broch and Vedel (2012) have also introduced a "purpose" attribute in a choice experiment related to Danish afforestation contracts but each level of this attribute (i.e. biodiversity, water protection or recreation) implied different forest management options and therefore different implementation costs. In our design, all hypothetical contracts include the same technical prescriptions: eligible plots are fields which were either previously planted with cereals, temporary pasture or abandoned land, and must be planted, under contract, with an alfalfa crop, which is expected to provide suitable habitats for nesting birds. They incur the

same costs for the same farmer. Therefore differences in WTA can be attributed to framing differences, thus triggering various motivations.

The hypothetical contracts offered in the CE differ on three attributes.

The main attribute of interest is the purpose of the contract (purpose): it is presented either as a conservation or as a compensation contract, using the definitions mentioned above. This attribute embodies two major differences: the overall aim of the contract (compensation vs conservation) and the contracting partner (private vs public). Another approach could have been to separate these two characteristics in two distinct attributes and to analyze preferences separately. Our assumption was however that these two characteristics were understood as intimately mingled and that it would have been perceived unrealistic by farmers to present them separately (in particular the case of a conservation contract proposed and financed by a private company).

The second attribute is linked to the specific needs of biodiversity conservation. It introduces the option to impose (or not) a 20% minimum threshold of farmer participation to trigger the implementation of the contract scheme. This minimum threshold is justified by the need to obtain a sufficiently sized habitat in order to ensure bird successful reproduction. When a minimum level of practice or land use change is necessary to reach a significant environmental impact on a given territory, the policy-maker may decide to set a minimum threshold of enrollment (Dupraz *et al.*, 2007). In this context, if public authorities impose to the developer that such threshold be attained, the developer may wonder whether revealing the existence of the threshold to farmers will encourage or hinder farmers' participation. On the one hand, farmers who do not want to provide environmental effort without any positive environmental outcome might approve such a threshold which guarantees a minimum environmental impact of their land use change. On the other hand, we can expect that farmers might be reluctant to condition their participation on the decisions of others. The effect of such an announced threshold is indeed controversial in the literature. In a threshold public good game experiment, Le Coent *et al.* (2014) show that the introduction of a minimum threshold of contribution triggering the payment of subsidies tends to increase subjects' contribution. In a choice experiment, Kuhfuss *et al.* (2014) found that farmers have a strong preference for the inclusion of a bonus conditional to a minimum threshold of participation in agri-environmental contracts aiming at reducing herbicides use in vineyards. However, Villanueva *et al.* (2015) reveal in a choice modeling that the inclusion of such collective

threshold tends to discourage participation in agri-environmental contracts because farmers anticipate additional transaction costs.

The third attribute is the payment associated to the contract. It is either 170, 200, 230 or 260 €/ha/year. The variation of payment is centered on the present level of payment for this measure in AES and ABOS which is 215€/ha and year. We deliberately included a modest variation of payment because we expected that the payment level could play a very strong role in farmers' decisions as compared to the other two attributes.

The attributes and the payment levels were discussed with the organizations in charge of the implementation of the biodiversity offsets program carried-out in the field. In addition, the questionnaire was tested with a small sample of farmers to check that it was properly understood.

### **2.3 Experimental design**

Considering that the choice experiment questions were included at the end of a lengthy questionnaire dedicated to another research, our constraint was to be parsimonious and to limit the set of choices that farmers had to make to a minimum. A full factorial design with 2 alternatives would have required  $(2 \times 2 \times 4) \times (2 \times 2 \times 4 - 1) = 240$  possible choice situations. We therefore used a fractional factorial design. Huber and Zwerina (1996) show that if there are reasonable non zero-priors on the effects of attributes on choice, then these can be used to generate choice designs that are statistically more efficient than a classic orthogonal design, because the alternatives in their choice sets are balanced in utility, i.e. they have more similar choice probabilities. We could not run a pilot due to the limited size of the population and the risk to reduce our end sample. Nevertheless, it was clear that the coefficient of the payment attribute would be positive. We therefore used a D-efficient design in which we only anticipated that the coefficient of the payment attribute was positive. The coefficient of the other attributes was set to 0. We generated a two block design with four choice sets each. Each respondent was randomly affected to one of the block and therefore was confronted with 4 choice sets. In each choice set, respondents had to choose between 2 hypothetical contracts that presented a combination of the above mentioned attributes and an opt-out option which was "neither of the two contracts". A sample choice set is presented in appendix 8.

There is a debate in the literature on the inclusion of an opt-out option in discrete choice experiments. One of the advantage of the "opt-out" option is that it makes the choice situation

more realistic and avoids a forced choice (e.g. Batsell and Louviere, 1991; Haaijer *et al.*, 2001). Several studies from the experimental psychology and marketing literatures have shown that respondents faced with a forced choice tend to choose certain options in the choice set that may create biases (Tversky and Shafir, 1992; Dhar, 1997; Dhar and Simonson, 2003; Kontoleon and Yabe, 2003). But one of the disadvantages of the opt-out alternative is that respondents may select the opt-out alternative, not because it provides the highest utility among the alternatives but because it allows them to avoid the cognitive task of comparing alternatives (Dhar, 1997; Dhar and Simonson, 2003). Since the opt-out alternative does not vary across choice sets, it gives no information about preferences for attributes, but it is a way to determine the potential participation to a program and it should be included if in real life ‘not participating’ is an option as well. However, the use of an opt-out option may cause the utilities of the choice alternatives to be correlated leading to the violation of the “independence of irrelevant alternatives” underlying the conditional logit model (Amaya Amaya, 2003).

Another issue is whether a “status quo” option or an opt-out option should be used in choice modeling. The “status quo” option for agri-environmental contracts would mean “choose the non-hypothetical contract which is presently proposed to farmers”. It can be described by specific levels of the CE attributes (whereas the “opt-out” option is not defined by contract attributes) but it forces respondents to pick a contract situation. Among the studies that used choice experiments to estimate the preference for agri-environmental contract attribute, the opt-out option is generally privileged (Ruto and Garrod, 2009; Espinosa-Goded *et al.*, 2010; Christensen *et al.*, 2011; Broch and Vedel, 2012; Kuhfuss *et al.*, 2014). In order to fit to a context in which farmers voluntarily chose to enroll or not in an AES, we chose to include an opt-out option “I chose none of the two contracts” in each choice sets.

The coding of variables in a choice experiment with an opt-out option poses a number of challenges. Haaijer *et al.* (2001) determine that the best option is to use effect coding for the attributes. Each attribute is coded with an additional level set to 0 for the opt-out alternative. A supplementary two-level attribute is added. It takes value zero for the two contract alternatives and value one for the opt-out alternative. This dummy variable can be interpreted as the utility for the respondent of choosing the opt-out alternative (Vermeulen *et al.*, 2008), capturing a preference for the “no change” option. The coding adopted is presented in Table 38.

Attribute	Description	Levels	Coding
Purpose	Aim of the contract	Compensation of biodiversity loss	+1
		Conservation of biodiversity	-1
		Opt-out	0
Threshold	Existence of a minimum threshold of participation of 20% of farmers of the area	Yes	+1
		No	-1
		Opt-out	0
Payment	Payment level per ha and year	170€/ha	170
		200€/ha	200
		230€/ha	230
		260€/ha	260
		Opt-out	0
Opt-out	None of the 2 contracts	Opt-out	1
		Real-choice options	0

Table 38: AES attributes, levels used and their coding

## 2.4 Data collection

The questionnaire was sent by post to the 1169 farmers who were initially contacted by the developer since 2011 to sign an ABOS contract, of which 59 (5%) have effectively enrolled. Note that the hypothetical contracts described in the CE were not presented as a substitute for their current contract but as new additional contracts on different land. Only farmers who had available cereal field, temporary pasture (without alfalfa) or abandoned land were invited to fill the choice modeling part of the questionnaire. We collected a total of 121 responses (response rate of 10.3%) to the questionnaire of which 82 usable replies to the choice modeling questions. Respondent also had to answer a number of questions on their socio-economic characteristics, and their opinion and attitude towards the environment, and their perception of the trustworthiness of the private contracting partner (the developer).

Descriptive statistics on the socio-economic characteristics of the sample are presented in Table 39 and are compared to the farmer population in the area.

Variable	Modality	Freq.	% of the 82 respondents	Reference (%)	Variable	Modality	Freq.	% of the 82 respondents	Reference
<b>Gender</b>	Male	65	79.3	73.8	<b>Main farm activity</b>	Field crops	12	15.2	4.5
	Female	17	20.7	26.2		Horticulture	7	8.9	10.9
<b>Age</b>	Less than 40	14	17.1	16.9		Vine growing	34	43.0	53.8
	From 40 to 49	19	23.2	25.0		Orchard	4	5.1	13.2
	From 50 to 59	27	32.9	30.6		Livestock	15	19.0	6.6
	60 or more	22	26.8	27.6	Other	7	8.9	11.0	
<b>Farm size</b>	Less than 20 ha	24	29.3	67.5	<b>Education</b>	Primary	11	13.4	21.5
	From 20 to 50 ha	28	34.1	21.6		Secondary short	14	17.1	33.9
	From 50 to 100 ha	12	14.6	7.0		Secondary long	26	31.7	21.2
	From 100 to 200 ha	12	14.6	2.6		Superior	31	37.8	23.3
	200 ha or more	6	7	0.6					
<b>Importance of farming activity</b>	Principal	69	85.2		<b>Organic agriculture</b>	Yes	24	29.3	12
	Secondary	11	13.6			No	58	71.0	88
	Retired	1	1.2						

Table 39: Descriptive statistics of the survey sample (Reference: General Agriculture Census Agreste 2010 for the Gard department)

These statistics show that our sample is not biased in terms of gender and age. However, respondents are slightly more educated and farms are bigger than in the population of interest. There are two major differences: 29% of our sample declare themselves as “organic farmers” (they may be certified organic farmers, or in the process of certification, or have organic practices without certification) whereas the average share of certified organic farmers in the region is 12%. It might be partly explained by the fact that the organic qualification in our sample is broader and less restrictive than the definitions used in the official statistics. We can also suspect that there is a self-selection bias: farmers who are more susceptible to environmental issues, such as organic farmers, may have been more inclined to respond to a questionnaire dealing with biodiversity issues. The second difference is participation to contracts: among the 82 respondents, 25 (30% of our sample) have signed a compensation (ABOS) contract, 8 have signed a conservation (AES) contract and two have signed both. We have therefore also an over-representation of farmers enrolled in compensation contracts. It may bias our results either in favor of compensation contracts (selection bias) or against it (those who have signed have experienced dissatisfaction and express their discontent).

### 3 Results

#### 3.1 Preference for contract attributes

In this section, we first present the results of the average preferences of respondents of our sample for the contract characteristics. The analysis of the choice experiment data with the mixed logit are presented in Table 40. The preference for the opt-out, the aim of the contract and the threshold are considered to be normally distributed while the preference for the payment is log normal, avoiding to have negative preferences for the payment. The estimated price parameters are the mean  $b$  and standard deviation  $s$  of the natural logarithm of the payment coefficient. The mean and standard deviation of this coefficient are given by  $\exp(b + s^2 / 2)$  and  $\exp\left(b + s^2 / 2 \times \sqrt{\exp(s^2 - 1)}\right)$  respectively (Train, 2009).

Logit model estimation	Coef.
<b>Mean</b>	
Opt-out	10.14***
Purpose	-0.85***
Threshold	-1.35***
Payment	0.046***
<b>SD</b>	
Opt-out	-3.90***
Purpose	1.51***
Threshold	1.97***
Payment	0.024***
Nb. of observations	984
Nb. of individuals	82
Log likelihood	-228.27
Chi2	188.58

Table 40: Mixed logit estimation of choice experiment data.  
The sign of SD is irrelevant, must be interpreted as positive  
(\*p<.1, \*\*p<.05, \*\*\*p<.001)

The analysis clearly reveals that on average farmers are more likely to choose a conservation contract than a compensation contract. The WTA difference between attribute levels can be estimated by dividing the attribute coefficient by the payment coefficient. Because we use an effect coding, this ratio must be multiplied by 2. In our sample, farmers require 37 Euros more to accept a contract with a compensation objective rather than a contract with a conservation objective. This difference represents 17% of the present payment offered in this type of contract, which is surprisingly high for an attribute not entailing direct monetary costs or benefits, and for a sample which includes 30% of respondents who have effectively signed an ABOS.

The estimation of the threshold attribute confirms the results by Villanueva *et al* (2015). Farmers prefer contracts which are not conditional to a minimum participation level. They would require 59€ more to enroll in a contract that includes a 20% threshold of participation rather than in a contract that does not include a threshold. This difference might be linked to anticipated costs of transaction. Farmers are reluctant to engage into a contract procedure (which can be costly in terms of paperwork, compulsory meetings with extension workers etc.) which may not be finalized. Revealing the existence of such threshold might therefore be counterproductive for the developer because it will discourage some farmers to participate in the contracts.

There is also a significant preference for the opt-out option, i.e. the non-participation in any of the contracts. This is also a result obtained by other choice experiments on agri-environmental contracts. Quite a large number of farmers prefer the status quo and are reluctant to engage in a contract whatever the contract terms and payments might be.

### **3.2 Analysis of preference heterogeneity**

The mixed logit analysis reveals that there is a significant preference heterogeneity for the contract purpose. What are the factors explaining preference heterogeneity? The literature review in section 1 suggests that several behavioral factors may explain the preference for conservation contracts over compensation contracts. The main drivers are expected to be: environmental attitudes, the feeling of responsibility for nature conservation, and trust between contracting partners.

The questionnaire included questions to test these hypotheses.

The level of environmental attitude is evaluated with two variables. The first one is the fact to declare oneself as an organic farmer or not (ORGA variable). The second is built from an opinion question. Respondents were asked to indicate whether they agreed (totally disagree, partially disagree, partially agree, totally agree and don't know) with the statement "The protection of threatened bird species is a priority for our territory" (variable BIODIV).

Trust with the developer (variable Trust) was estimated by the level of agreement with the statement "I believe that the developers who fund ABOS are trustworthy". Another way to measure the degree of trust between farmers and the developers is to assume that those who have signed an ABOS have more confidence in the developer's commitments. We thus also use a dummy variable (SIGN) which takes the value 1 if the respondent is already enrolled in a compensation contract.

We measured respondent's feeling of environmental responsibility (variable RESP) by their level of agreement with the statement: "I think it is my responsibility, as a farmer, to act for the protection of threatened bird species".

	Totally disagree	Partially disagree	Partially agree	Totally agree	I don't know
The protection of threatened bird species is a priority for our territory (BIODIV)	2	2	37	31	8
I think that developers who fund ABOS are trustworthy (TRUST)	5	3	32	8	33
I think this is my responsibility, as a farmer, to act for the protection of threatened bird species (RESP)	3	4	35	34	5

Table 41: Frequency of response to three questions involved in the interpretation of preference for the purpose of contracts

We decided to turn these variables into dichotomous variables to simplify the analysis, with shaded cells coded as 1 (generally agree) and white cells as 0 (generally disagree or don't know). The coding was slightly different depending on the question in order to ensure a balanced frequency in the classes. The analysis of the interaction between the preferences for the contract was made by repeating the analysis of Table 40 with the addition of one simple interaction one at a time (models 1 and 5 in Table 42) as well as all interaction terms (model 6 in Table 42).

	(1)	(2)	(3)	(4)	(5)	(6)
<b>Mean</b>						
Opt-out	12.28***	10.75***	12.83***	14.74**	13.34***	16.4***
Purpose	-0.60*	-0.74**	-0.70	-1.10**	-0.85**	-0.35
Threshold	-1.61***	-1.05***	-1.09***	-1.24***	-1.20***	-1.92***
Payment	0.063***	0.051***	0.060***	0.074***	0.062***	0.076***
Purpose*ORGA	<b>-1.32**</b>					<b>-2.32**</b>
Purpose*BIODIV		0.03				-0.44
Purpose*TRUST			-0.17			-0.00
Purpose*SIGN				0.86		
Purpose*RESP					-0.37	-0.64
<b>SD</b>						
Opt-out	-5.94***	-5.89***	-4.82***	-6.07***	-6.76***	-9.77***
Purpose	-2.08***	1.56***	1.83***	1.87***	1.95***	-1.70**
Threshold	2.52***	2.16***	2.07***	2.60***	2.49***	3.03***
Payment	0.35***	0.028***	0.026***	0.037***	0.033***	0.029***
Purpose*ORGA	-1.58***					-3.49
Purpose*BIODIV		1.53*				-1.00**
Purpose*TRUST			0.13***			-0.66**
Purpose*SIGN				1.08**		
Purpose*RESP					0.03**	1.67**
Nb. of observations	984	960	972	972	972	960
Nb. of individuals	82	80	81	81	81	80
Log likelihood	-222.47	-215.70	-216.68	-215.88	-215.02	-206.47
Chi2	195.84	197.50	203.45	204.81	206.60	209.50

Table 42: Mixed logit estimation of choice experiment data. Opt-out, Purpose, threshold and interaction terms are considered normally distributed and payment is log-normally distributed.

The only variable which has a significant interaction parameter with the “purpose” attribute is the variable ORGA (the fact to be an organic farmer) and the significance level holds in the model with multiple interactions (model 6). Farmers who declare to be organic farmers display an even larger preference for conservation contracts than the overall sample. The other variables indicating environmental attitude (BIODIV), environmental responsibility (RESP) or the extent to which farmers trust the developer (TRUST) are not significant.

Among the 23 organic farmers of our sample, only 3 have signed a compensation contract. They are three times less numerous to sign such contracts compared to the overall sample. This is coherent with their preference. The questionnaire also included a question, which was asked before the choice experiment, on the respondents’ general opinion on offset programs. To the question “What is your opinion on BO through agriculture?”, they could respond “very

negative” or “rather negative” (negative), “rather positive” or “very positive” (positive) or do not know.

	Organic farmers	Others
Positive opinion	4	15
Negative opinion	17	16
Do not know	3	27

Table 43: Number of farmers according to their general opinion on biodiversity offsets

We can confirm here that organic farmers are more numerous proportionally (74% against 27%) to declare that they have a negative opinion of compensation contracts (Table 43).

We have confidence that being an organic farmer is a reliable indicator of the farmer’s susceptibility to environmental issues. The result tends to confirm that the attitude towards the environment may be the main variable explaining preference for conservation contracts, or, alternatively, aversion for compensation contracts.

## 4 Discussion and conclusion

This study is the first choice experiment seeking to measure farmers' relative preferences for the ultimate aim of an agri-environmental contract with equal technical prescriptions. Although the sample size remains limited, the results are noteworthy in several respects, both for operational recommendations on the implementation of offset contract, and for further research on the value of farmers' free contribution to the environment.

On the operational side, this study confirms that all in all offset contracts are an acceptable form of contracts by farmers and could be used as a tool for the implementation of biodiversity offsets. However, developers must be prepared to pay farmers more in ABOS than the level of payment used in equivalent AES, if all other aspects of the contract are equal. This "compensation premium" will need to be particularly high in areas where farmers are aware and susceptible to environmental issues. Since results confirm that the way contracts are framed has an influence on farmers' participation and willingness to accept (Research question 5 of the general introduction of the thesis), developers may be well advised to mask – or at least not insist on - the fact that contracts are used for the compensation of biodiversity losses created by infrastructure development. We have confirmed also that farmers are averse to conditional contracting programs which are triggered only if a minimum participation threshold is attained. However, it might well be the only option for developers who need to have a guarantee on the effective delivery of the required offset area and who cannot take the risk to pay contracts without meeting their legal obligations. This has a price since farmers are averse to such conditionality.

Finally, the preference for conservation contracts limits the risk of competition of BO programs with traditional conservation policies, which could jeopardize the additionality of biodiversity offsets. The risk remains however, especially if the developer's willingness to pay is high. This is the case when the land purchase option is much more costly than the contract option.

Our choice experiment can also bring new light to the issue of farmers' voluntary contribution to environmental public goods. As stated before, our CE results reveal either farmers' preference for conservation contract or aversion for compensation contracts. It is in fact difficult to disentangle the two. If it is interpreted as a dislike for the overall concept of biodiversity offsets (stronger for environmentally aware farmers), signing an offset contract

results in a stronger disutility, a kind of outrage, which must be compensated by a higher payment. The alternative interpretation is to consider that participating to a conservation contract is perceived by farmers as a contribution to a public good. For participating farmers, there is an altruistic utility gain from the provision of public good and possibly an impure altruistic utility gain from the warm-glow feeling of “doing good”. Their WTA is therefore inferior to the true monetary costs of complying with the contract. Considering that biodiversity offsets do not contribute to an overall improvement of the environment, these benefits are not perceived with compensation contracts, in a sort of eviction of environmental attitude. Participating to a compensation contract is therefore considered as a standard transaction of service between the private developer and the farmer. Farmers therefore require a payment that at least covers their full compliance costs. Following this interpretation, the WTA difference between compensation and conservation contracts would be a monetary estimation of the “free” contribution to the biodiversity conservation that farmers are ready to make when they participate in a biodiversity conservation AES. In our case study, it amounts to nearly 20% of the average payment for such contracts which is relatively high. For organic farmers, it goes up to more than 60 €/ha, thus amounting to 28% of average payment. It suggests that conservation contracts could be offered to organic farmers for a payment which is one third lower than presently.



## GENERAL CONCLUSION

This PhD thesis is about the role of behavioral factors in the adoption of AES. It also analyzes the performance of innovative contract designs and the way it is affected by behavioral factors. In this general conclusion, the first section outlines the main findings of our research on these two themes. In the second section, I draw some general conclusions on the role of behavioral approaches in agri-environmental policies. Considering that this thesis has used stated preference and experimental methodologies, the third section describes insights on the complementarity of these two approaches. Finally, the fourth section highlights the limits and possible extension of this research work.

### 1 Main findings

Because the role of psychological and social forces has not been sufficiently taken into account in agri-environmental policies and more particularly in AES programmes, the first part of the thesis aims at analyzing the role of behavioral factors in the participation to AES. **Chapter 1** is dedicated to an exploratory work of the motivations underpinning the adoption of AES. It uses the Theory of Planned Behavior (TPB) (Ajzen, 1991). This theory is applied to the case of a vine-growers' cooperative in which an AES for the reduction of the use of herbicide is proposed. We use an enriched version of the TPB that includes the standard predictors of behavior - attitude, perceived behavior control and subjective (or injunctive) norm - and additional variables considered to have importance in pro-environmental behavior: descriptive norms, personal norms, past behavior and perceived response efficacy. We complete this analysis with an estimation of beliefs that are considered to precede attitude, perceived behavior control and the subjective norm.

51 face-to-face interviews are carried out with farmers and analyzed using multivariate regression and logit estimations. As expected, the analysis reveals that farmers are influenced by traditional economic motivations: the perceived behavioral control and the perception of costs, as compared to payment proposed. We also highlight some of the constraints and negative outcomes which influence adoption: the lack of technical flexibility in weed control

in AES contracts, the feeling of loss of autonomy, the perception of being submitted to financial constraints and the lack of information on contracts.

Interestingly, the analysis also reveals that farmers are influenced by two behavioral factors: the personal and the subjective (injunctive) norm. Farmers who believe that people important to them are in favor of their adoption are significantly more likely to adopt. People who have the most influential opinion are spouses and cooperative technicians. We had expected that farmers would be influenced by the decision of other farmers and their opinion about AES. This analysis reveals that this is only partially the case. Only referent/leader farmers are perceived to be influential. Neighbor farmers seem to have little influence or not on farmers' decisions.

Because the TPB survey highlighted the role of norms, **chapter 2** focuses on a deeper understanding of the role of social norms in the adoption of AES. The chapter first reviews academic contributions on the definition of social norms. It highlights the difference between *descriptive norm*, or what the others do, *injunctive norm*, or what the others' think one should do (Cialdini *et al.*, 1990), and *personal norms*, what one think he should do. Finally, Bicchieri (2006) proposes a more complex definition: social norms exist on condition that (a) people expect others to follow it and (b) people believe that, in turn, they are expected by others to follow the norm. We emphasize two different aspects of social norms based on these definitions : i) the fact that norms are based on individual perception of opinion and decision of others, that may actually be subject to misperception, and ii) the fact that norms need to be salient in order to have an effect.

After a review of existing economic models taking into account the role of social norms, we develop a model based on Rege's work (2004) in which we analyze the effects of both the descriptive and the injunctive norms on the participation to an AES programme. We model the influence of social norms based on two assumptions particularly tailored to the context of AES. First, we consider that farmers may be influenced by the effect of the descriptive norm in two different directions. When the adoption rate is low, farmers who decide not to adopt feel approval (they conform to the descriptive norm) and the ones who decide to adopt feel disapproval. We argue that although adopting an AES is a pro-social activity, the descriptive norm may actually be anti-social when too few farmers adopt. The exact contrary occurs when a sufficient number of farmers adopts, farmers who do not adopt feel disapproval while farmers who adopt feel approval. In summary, the descriptive norm tends to induce people to

do what the majority of people already does but not to impulse a change of behavior. The second assumption is that the injunctive norm is not exerted only by farmers but by all members of the society. In our model, we consider that the injunctive norm is determined by the environmental good production level. When the state of the environment is degraded, the injunctive norm in favor of a change of farming practices is strong. The influence of this injunctive norm decreases when environmental quality improves (directly linked in our model to the level of participation in AES). Consequently farmers receive approval when they adopt and disapproval when they don't but the magnitude of both these effects decreases when the adoption of AES become generalized. We highlight that the combined effect of these norms may lead to a stable equilibrium in which the participation remains low. This prediction of the model may illustrate well the situation of territories in which AES adoption remain blocked at low levels.

We carry out an online survey to confirm the results of the TPB with a wider sample and to illustrate the results of our model. 98 farmers eligible to AES for the reduction of pesticide use of the Languedoc Roussillon Region replied to the survey. The analysis shows that three variables are strongly and consistently involved in the decision to adopt: the perceived difficulty linked to the adoption, the injunctive norm exerted by important others and the personal norm. Again, as in the TPB the role of the descriptive norm and the opinion of other farmers does not seem to be a key factor in individual decisions to adopt AES. If we analyze our data relatively to the results of model, we may be in a situation where the injunctive norm, along with financial incentives, is driving farmers' adoption of pro-environmental practices.

We conclude this chapter by proposing a number of policy recommendations that take into account the role of social norm and personal norms. Three possible policy options are considered.

First, strengthening the salience of the descriptive norm ( $\lambda$  in our model) could be an option considering its low present effect, but we highlight that this may actually be counterproductive. Indeed the descriptive norm hampers adoption when participation is low.

Second, because the injunctive norm appears to have a significant effect on adoption, communication campaigns on the injunctive norm could be a relevant intervention. Farmers particularly care about the opinion of referent technicians, referent farmers and spouse. We therefore recommend the targeting of these populations to increase social pressure and indirectly induce farmers to modify their agricultural practices. The French Ministry of

Agriculture has developed a network of 1900 referent farms, the DEPHY farms, to demonstrate that agriculture with low pesticide use is technically possible. We argue that farmers that are considered to be referent by other farmers could be the ones to include in priority in such networks in order to maximize the effect on other farmers. Communication could also be targeted at a larger public. For example, for water quality issues, municipalities and water agencies should develop the communication on water quality data to local communities at large, rather than targeting only farmers. The European directive 2003/4/CE on access to environmental information gives a legal framework for this type of initiative.

Third, we propose interventions that may modify beliefs on other farmers' participation in AES (modify the perception of  $x$  in our model). This may be achieved through the development of innovative designs which payment is conditioned to a minimum threshold of farmers' participation, such as the collective bonus studied in Kuhfuss et al. (2014) or AES with collective conditionality which we study in chapter 3.

**In part 2**, we analyze the performance of innovative AES designs and how these performances may be affected by behavioral issues. In **chapter 3**, we test an AES in which payments are conditioned to a certain level of collective participation. Traditional agri-environmental contracts are individual, action-based and voluntary. They have had disappointing environmental outcomes despite the large amounts dedicated to their implementation. One of the main reasons for this unsatisfying outcome is the limited and scattered adoption of contracts and the existence of environmental thresholds. We use a threshold public good experiment to test an agri-environmental contract with a collective conditionality. It is a new form of contract in which farmers are paid only if the environmental threshold is collectively attained. This contract may be seen as a collective result-based contract. It requires coordination among group members to reach the threshold and therefore trigger the payment of the subsidy. This form of contract, henceforth conditional subsidy scheme, may harness the role of descriptive social norms, by modifying the perception of others' decisions. It is compared to traditional AES schemes represented by an unconditional subsidy of individual contributions to the public good. The experiment is run in a laboratory setting with 220 students. Our experimental results show that conditional agri-environmental contracts are more efficient than traditional ones and improve the environmental outcome. We investigate behavioral factors that may affect the participation to this scheme. We find that early stages of implementation of this mechanism are fundamental for its success. The conditional subsidy scheme increases expectations on others' contribution in the first period

(a sort of descriptive norm) that in turn leads to an increase of contribution that is generally sustained over time. Risk aversion can however affect the effectiveness of this mechanism. Indeed, groups that are composed of the most risk averse subjects tend not to manage to coordinate above the threshold. We conclude that this new form of contract should be considered in the design of future agri-environmental policies to increase their efficiency. Conditioning the whole AES payment to the participation of others may however be politically difficult. Other options such as conditioning only a portion of the payment (a conditional bonus) may be more feasible in the field.

Chapter 4 and 5 deal with a new application of AES contracts to the compensation of biodiversity. Environmental policies increasingly refer to biodiversity offsets (BO) as a way to slow or halt biodiversity losses caused by development projects, including infrastructure and urban development. **Chapter 4** analyzes the advantage and drawbacks of implementing biodiversity offsets by involving farmers in the production of ecological gains through a new form of AES that we call Agri-environmental Biodiversity Offsets Schemes (ABOS). It studies an offset programme designed and implemented in Southern France to compensate the residual biodiversity losses induced by the construction of a new railway line. This chapter examines (1) the acceptability of ABOS contracts by farmers, and (2) the effectiveness of ABOS design and actual implementation. A survey carried out with 145 farmers reveals that the main determinants of acceptability are: i) usual economic factors whereby farmers with lowest compliance levels and opportunity costs, as well as farms facing economic difficulty, are more likely to engage, and ii) social factors, such as the importance given to other farmers' participation (descriptive norm) and the individual perception of the political position of farming organizations on ABOS (injunctive norm). This emphasizes again the role of social norms on the adoption of AES-like contract. In terms of effectiveness, ABOS is shown to be effective in meeting the legal requirements of the developer, but concerns are raised about additionality and long-term duration of actions, as well as non-compliance with contract requirements. We particularly highlight problems with contract enforcement – especially due to weak sanctions and monitoring – and farmers' selection that do not allow minimizing moral hazard and adverse selection which are inherently attached to AES. We suggest policy improvements to enhance the implementation of offsets through ABOS: i) the use of agri-environmental auction and/or result based contracts and ii) the implementation of a monitoring and control system by the administration that ensures that the developer, in turn, monitors and controls the implementation of ABOS. Overall, with current implementation

arrangements, this analysis leads us to question the relevance of developing ABOS as a way to meet the objective of “no net loss” of biodiversity.

**In chapter 5**, we analyze whether the contract framing may affect the participation to agri-environmental contracts. We question whether AES, which are presented as a net contribution to environmental quality, are perceived differently from an offset contract (such as ABOS) aiming at restoring environmental quality to its original level, after it was damaged by human intervention. Does this difference of framing impact farmers’ willingness to participate? The preference for compensation contract versus conservation contract may be influenced by different behavioral factors. First, the compensation could be considered as the restoration of a loss of biodiversity and should therefore be preferred, due to loss aversion. Second, in the compensation frame, the developer is clearly responsible for the environmental degradation and farmers may not want to be considered accomplice of this degradation. Third, farmers who are the most favorable to environmental issues may prefer conservation contracts as they entail a better ultimate environmental quality. Finally, there may be a difference of trust between contracting partners between AES (Farmers and the State/Europe) and ABOS (Farmers and the private developer)

We implement a choice experiment (CE) with 82 farmers to quantify the preference for the two different contract framing. Our results show that on average farmers are more likely to choose a contract with an objective of conservation than a contract with an objective of compensation. In our sample, farmers require 37 Euros more to accept a contract with a compensation objective rather than a contract with a conservation objective. We also analyze which behavioral factors may be influential by testing the interaction between the observed preference and indicators of susceptibility to the four possible underlying behavioral causes. We show that susceptibility to environmental issues may be the reason for this result. Farmers who are the most committed in the adoption of pro-environmental practices (organic farmers) are the ones who are the less willing to participate in ABOS. This result invites agencies in charge of promoting ABOS contracts to carefully design their communication to farmers. If ABOS objectives are presented as a contribution to the conservation of biodiversity, they may indeed be more easily accepted than if they are presented as a compensation of biodiversity losses.

## 2 Behavioral approaches in agri-environmental policies

This PhD thesis emphasizes the role of behavioral factors, such as social norms, personal norms and framing, along with traditional economic motivations in farmers' decisions to participate in agri-environmental schemes. These behavioral factors intervene in both traditional AES as well as innovative contract designs: subsidy schemes with collective conditionality or Agri-environmental Biodiversity Offset Schemes. Behavioral factors may either contribute to the effectiveness of AES or hamper their effectiveness.

The importance of these factors has not yet been sufficiently taken up in Europe, except in the UK. There is therefore a need to strengthen behavioral approaches in the conception and implementation of agriculture policies. Two direct uses of behavioral approaches seem to be particularly relevant in agri-environmental policies:

- **Reshape incentives in order to harness the effect of behavioral factors and/or avoid inefficiencies due to behavioral factors.** One of the examples is the conditional subsidy scheme proposed in chapter 3, which may harness the effect of the descriptive norm in order to provoke a wider participation. In chapter 5, we highlight the negative effect of the framing of ABOS, as a compensation of ecological damages, on farmers' WTA. Changing the way contracts are presented to farmers would be a way to avoid this source of inefficiency.
- **Developing the use of green nudges.** Although we have not tested nudges in this thesis, our finding of the influence of norms calls for the possible use of this type of instrument to strengthen farmers' adoption of pro-environmental behavior.

In my view, these two approaches should be considered concomitantly. In countries where behavioral economics has become influential, there is a temptation to substitute costly traditional policy instruments such as incentives by low cost behavioral interventions such as "green nudges". This is a risky strategy. Farmers are influenced by a diversity of motivations, such as intrinsic and extrinsic motivations. Multifactorial approaches are therefore needed to ensure farmers adopt more pro-environmental practices: incentives such as AES, regulatory measures and behavioral interventions. The diversity of factors at play explains why inducing durable changes has been so difficult for policy makers over the years. Interventions must

address a number of factors at once, and be flexible to different audiences and contexts (Darnton, 2008).

Our results however suggest that a category of farmers refuses to enroll in AES now or in the future. Letting these farmers out of agri-environmental policies could be particularly problematic because they are likely to be the largest polluters. Which EU policies could target these farmers? They may be targeted by the “greening” of the CAP and by the minimum standards mentioned in the “Good Agri-environmental Conditions”. These measures are however largely permissive and affect only farmers that receive payments from the CAP (this is not the case for many farmers such as greenhouse growers or vine-growers). Another frequently recommended option to target these farmers is the use of regulatory measures. However, this would require a particularly strong political will considering the probable resistance of farmers’ unions against these mandatory approaches. It is thus not likely to happen in the current European political context. The use of green nudges could therefore be an innovative and politically acceptable way to facilitate the adoption of pro-environmental practices by these “reluctant” farmers.

Some precautions are nevertheless necessary in the way nudges are used. This policy instrument may indeed generate a feeling of loss of autonomy and manipulation that could jeopardize its effect (Schubert, 2016). This could be a particularly sensitive question in farming communities, as there are sometimes suspicions on the good intention of government authorities. This calls for a certain transparency on the presentation of these policy measures. There is however a tradeoff in the level of transparency, as revealing all information may actually jeopardize the effects of nudges, which somehow relies on the fact that people are influenced without noticing.

The use of behavioral approaches could be more largely included in the main steps of the agriculture policy design and implementation cycle presented in Collier *et al* (2010):

- **Understanding the situation.** Behavioral approaches may help understanding the farmers’ underlying motivations to adopt or not pro-environmental practices. This may help identifying adequate policy interventions. Part 1 of our PhD thesis for example shows the role played by injunctive and personal norms in farmers’ choice to enroll in AES.
- **Developing and appraising options.** Economic modeling is a useful method to evaluate *ex ante* the performance of agriculture policies. Incorporating behavioral

factors in these economic models would be key to get better predictions of the performance of policy interventions, such as AES. A wider use of experimental economics, one of the major tools of behavioral economics, would also be particularly relevant to test new policy instruments and establish how their performance may be affected by behavioral factors (Colen *et al.*, 2016). In chapter 3 and 5, we present the testing of innovative AES designs with a laboratory experiment and a choice experiment.

- **Preparing for delivery and implementation.** Behavioral approaches can provide insights on an appropriate use of communication campaigns that could improve the results of policies. It is essential to recognize the importance of social factors (such as social norms) at this stage. This implies for example to make sure that trusted intermediaries are mobilized for policy implementation.
- **Monitoring and evaluation.** Traditionally, monitoring and implementation only consider the impact of policies on farmers' decisions, mainly in terms of practice. Behavioral approaches call for the monitoring of policy impacts not only on behavior but also on underlying farmers' motivations.

This development of behavioral approaches in the EU would require the implementation of capacity building programme. This has been initiated in the recent past through the creation of experts team such as the Behavioral insights Team in the UK. In Europe, this could be done by mobilizing current initiatives, such as the EU policy lab, on agriculture issues. At the French level, the appointment of behavioral economists and social psychology experts, to advise the government including the Ministry of agriculture would be a first step. At the more local level, the recent appointment of a behavioral economist at the EP Loire, institute in charge of the management of water issues in the Loire Basin in France, is an example that could be replicated. Capacity building programmes on behavioral issues should finally be developed for professionals that are directly in contact with farmers on farming practice issues. For example, in France, some watersheds have been considered a priority due to water quality issues. Facilitators have been appointed to stimulate initiatives on water quality. These facilitators who are interacting with farmers on a daily basis should be trained on the use of behavioral approaches.

### **3 The use of stated preferences and experimental methodologies**

In this thesis, we have mobilized both stated preference and experimental methodologies but, stated preference methodologies dominate. The use of these methodologies was fundamental in this phase of exploration of the role of behavioral factors in the performance of AES (part 1). Further work will require the use of experimental methodologies in order, for example, to more firmly establish the role of injunctive and personal norms in the participation of AES. This will however be a challenge as manipulating these factors to identify their effects on an outcome such as the adoption of AES is not straightforward. We have also found a lack of effect of the decision of other farmers on individual decisions. This is at odd with other studies that seem to reveal the contrary (e.g. Chen *et al.*, 2009; Kuhfuss *et al.*, 2016). It must be highlighted that people are often reluctant to admit that their decisions might be influenced by a conscious (or non-conscious) comparison to what others choose to do. Our results, which are based on stated behavior not observed behavior, are maybe driven by a declaration bias. We will therefore need to improve the quality of the survey on this point or use experimental methodologies to confirm or infirm this result.

Our approach illustrates a possible archetype of research programme which aims at i) understanding behavioral factors involved in farmers' decisions and ii) identifying relevant policy measures. Stated preference methodologies are particularly relevant to understand the diversity of motivations that intervene in pro-environmental behavior. In addition, social psychology provides standardized guidelines for the identification of these motivations through questionnaires. These methods are however weak at establishing robust causality links between specific motivations and behavioral change. Experimental methodologies on the contrary, provide a better framework to demonstrate the causal effect of various behavioral factors on human decisions. The drawback of this more "rigorous" method is that it usually examines the effect of these different factors one by one in isolation. Experimental methods are also particularly relevant to test specific behavioral interventions, which may play on these factors, and determine their impact on farmers' decisions. This may be done in a phased manner using lab experiment, field experiment, discrete choice experiment and randomized control trials (Colen *et al.*, 2016).

This general course of action may however be challenged depending on the considered behavioral factor. Indeed behavioral factors that are grouped under bounded rationality

(Mullainathan and Thaler, 2000), such as aversion to loss, time inconsistency or framing effects, are frequently analyzed with experiments but may not be identified with stated-preference methodologies. Other behavioral factors, such as injunctive norm or personal norm, are difficult to evaluate in an experiment. It is indeed complicated to apply treatments that would modify the perception of these norms and observe the impact on a particular outcome. This is particularly complicated in economic experiments in which lying to subjects is rejected by the scientific community. Stated preference and experimental methodologies therefore appear to be complementary for the study of farmers' decisions and identification of appropriate intervention to trigger behavior change, as well as in the study of the diversity of behavioral factors.

#### **4 Limits and extensions**

The thesis presents several **limits of scope** that could be investigated in the future. Two are particularly worth mentioning.

First, the thesis considers only the importance of a set of behavioral factors, mainly social norms, personal norms and framing effects. Other behavioral factors linked to bounded-rationality such as aversion to loss, time inconsistency, which may also have an impact on AES adoption have not been considered in this study. Other factors, close to bounded rationality, that are rather emphasized in psychology, such as the role of emotions or the fact that people use heuristics to take decisions have also not been studied. We did not either consider the potential negative effect of monetary incentives (crowding out effect) on intrinsic motivations, such as personal norm for example. This phenomenon may particularly occur in situations where farmers had already adopted a pro-environmental practice, then received incentives during a few years through AES to keep on doing so, and then this incentive was discontinued. There is a risk that farmers may cease this activity as a consequence of the end of this monetary incentive, while they were doing it before without it.

Second, we have mainly considered the role of behavioral factors in the adoption of AES and not in the adoption of pro-environmental practices. This was a choice we initially made because we considered that monetary incentives through AES are necessary to ensure practice change. It would however also be relevant to directly investigate the effect of behavioral factors on the adoption of pro-environmental practices in the absence of monetary incentives.

This thesis finally presents several **methodological limitations and possible extensions**.

The first one is that most of our empirical studies, except the experimental one present a relatively reduced sample. This limit is due to several reasons. First, the analysis of behavioral issues requires the collection of new data. Indeed, existing datasets generally do not contain information which can be exploited to analyze the impact of behavioral factors. The second reason is the difficulty to engage agricultural institutions in the participation to surveys and to share their databases. Consequently, we've had access to relatively small population of farmers. Finally, the response rate to surveys by farmers has also been quite low (around 10%). Despite this limit, we have been able to draw some significant and robust results from our econometric analysis, especially on the role of social norms.

We use experimental economics in chapter 3 to test a subsidy scheme conditioned on collective participation. This experiment is however only implemented in the lab with a sample of students. The results we have obtained therefore need to be confirmed with a population of farmers. The envisaged approach would be to first replicate the same experiment in the field, with the "lab in the field" approach and then to implement a contextualized experiment. Initially, it was also ambitioned to test innovative AES through a pilot implementation or the use of a randomized control trial directly in the field. A tentative project was developed with a consulting company, but the project was not funded. Identifying a local administration willing to test innovative AES and to fund the implementation of this scheme and the cost of incentives was a difficult task. It could finally not be achieved within the thesis duration but is still in discussion for an extension of the work.

The use of other approaches would also be relevant to analyze the influence of social norm in more details. For example, our results reject the importance of the opinion of neighbor farmers but the opinion of some selected referent farmers is important in farmers' decision. This would mean that convincing these few referent farmers may have a strong effect on the behavior of all farmers. Confirming this result, would require the use of methodologies to identify social networks and their role in the adoption of AES. Through this method, it would be possible to identify farmers that have a central role. Once identified, experimental approaches could be used to compare different facilitation methods and their impact on AES adoption: a standard general information approach and another one that focuses on central individuals in the network, using a similar approach as Banerjee et al (2013) on microfinance.

Finally, this work did little to analyze the possible impact of nudges. The only contribution is the participation to the research project on the impact of social information on the permanence of pro-environmental practices after the end of AES contracts (Kuhfuss *et al.*, 2016). Although nudges have been widely used in environmental policies at large, their application to agriculture still remains anecdotal. This opens large prospects for future research. For example, in light of the effect of injunctive norms on the adoption of AES, the use of nudges based on information on this particular norm could be a driver to strengthen AES uptake or the adoption of pro-environmental practices. Designing an experiment to test such a nudge coupled with state of the art impact analysis methodologies, such as randomized control trial, is an interesting lead for future research.



## REFERENCES

- Abbott, A., Nandeibam, S. and O'Shea, L., 2013. Recycling: Social norms and warm-glow revisited: *Ecological Economics*, **90**, p. 10–18.
- Ajzen, I., 1991. The theory of planned behavior: *Organizational Behavior and Human Decision Processes*, **50**, p. 179–211.
- Ajzen, I. and Fishbein, M., 2008. Scaling and testing multiplicative combinations in the expectancy-value model of attitudes: *Journal of Applied Social Psychology*, **38**, p. 2222–2247.
- Ajzen, I. and Fishbein, M., 2005. The Influence of Attitudes on Behavior. In: *The handbook of Attitudes* (Albarracín, D., Johnson, B., and M., Z., eds.) Mahwah, NJ, p. 173–221.
- Allaire, G., Cahuzac, E. and Simioni, M., 2009. Contractualisation et diffusion spatiale des mesures agro-environnementales herbagères: *Revue d'Etudes en Agriculture et Environnement*, **90**, p. 23–50.
- Allcott, H., 2011. Social norms and energy conservation: *Journal of Public Economics*, **95**, p. 1082–1095.
- Allport, G.W., 1935. Attitudes.
- Alpizar, F., Carlsson, F. and Johansson-Stenman, O., 2008. Anonymity, reciprocity, and conformity: Evidence from voluntary contributions to a national park in Costa Rica: *Journal of Public Economics*, **92**, p. 1047–1060.
- Amaya Amaya, M., 2003. 'None' Matters : In: *X Encuentro Economía Pública, Tenerife 5-8 Febrero 2003* (Tenerife, S., ed.) p. 1–24.
- Andreoni, J., 1990. Impure Altruism and Donations To Public Goods: a Theory of Warm-Glow Giving: *Economic Journal*, **100**, p. 464–477.
- Andreoni, J., 1995. Warm-Glow Versus Cold-Prickle: The Effects of Positive and Negative Framing on Cooperation in Experiments: *The Quarterly Journal of Economics*, **110**, p. 1–21.
- Ariely, D., Bracha, A. and Meier, S., 2009. Doing good or doing well? Image motivation and monetary incentives in behaving prosocially: *The American Economic Review*, **99**, p. 544–555.
- Armitage, C.J. and Conner, M., 2001. Efficacy of the Theory of Planned Behaviour: A meta-analytic review: *British Journal of Social Psychology*, **40**, p. 471–499.
- Armitage, C.J. and Conner, M., 1999. The Theory of Planned Behaviour : Assessment of predictive validity and 'perceived control: *British Journal of Social Psychology*, **38**, p. 35–54.
- Armitage, C.J., Conner, M. and Norman, P., 1999. Differential effects of mood on information processing: Evidence from the theories of reasoned action and planned behaviour: *European Journal of Social Psychology*, **29**, p. 419–433.

- Arrow, K.J., 1986. Rationality of Self and Others in an Economic System: *The Journal of Business*, **59**, p. S385–S399.
- Bagozzi, R.P. and Pieters, R., 2010. Goal-directed Emotions.
- Bamberg, S. and Rölle, D., 2003. Determinants of people's acceptability of pricing measures: replication and extension of a causal model: *Acceptability of transport pricing strategies*, p. 235–248.
- Bamière, L., David, M. and Vermont, B., 2013. Agri-environmental policies for biodiversity when the spatial pattern of the reserve matters: *Ecological Economics*, **85**, p. 97–104.
- Bandura, A., 1978. Self-efficacy: Toward a unifying theory of behavioral change: *Advances in Behaviour Research and Therapy*, **1**, p. 139–161.
- Banerjee, A., Chandrasekhar, A.G., Duflo, E., Jackson, M.O., Kitsak, M., Gallos, L.K., Havlin, S., Liljeros, F., Muchnik, L., Stanley, H.E., Makse, H.A., Ballester, C., Calvó-Armengol, A., Zenou, Y., Kermack, W., McKendrick, A., Aral, S., Aral, S., Muchnik, L., Sundararajan, A., McFadden, D., Ryan, B., Gross, N.C., Foster, A., Rosenzweig, M., Conley, T., Udry, C., Kremer, M., Miguel, E., Bond, R.M., Fariss, C.J., Jones, J.J., Kramer, A.D., Marlow, C., Settle, J.E., Fowler, J.H., Centola, D., Aral, S., Walker, D., Jovanovic, B., Nyarko, Y., Topa, G., Watts, D.J. and Strogatz, S.H., 2013. The diffusion of microfinance: *Science (New York, N.Y.)*, **341**, p. 1236498.
- Banerjee, S., Kwasnica, A.M. and Shortle, J.S., 2012. Agglomeration bonus in small and large local networks: A laboratory examination of spatial coordination: *Ecological Economics*, **84**, p. 142–152.
- Batsell, R.R. and Louviere, J.J., 1991. Experimental analysis of choice: *Marketing Letters*, **2**, p. 199–214.
- Beedell, J.D.C. and Rehman, T., 1999. Explaining farmers' conservation behaviour: Why do farmers behave the way they do? *Journal of Environmental Management*, **57**, p. 165–176.
- Beedell, J. and Rehman, T., 2000a. Using social-psychology models to understand farmers' conservation behaviour: *Journal of Rural Studies*, **16**, p. 117–127.
- Beedell, J. and Rehman, T., 2000b. Using social-psychology models to understand farmers' conservation behaviour: *Journal of Rural Studies*, **16**, p. 117–127.
- Benabou, R. and Tirole, J., 2012. Laws and norms: *IZA Discussion Paper* 6290.
- Bénabou, R. and Tirole, J., 2006. Incentives and prosocial behavior: *The American Economic Review*, **96**, p. 1652–1678.
- Berkowitz, A.D., 2004. The Social Norms Approach: Theory, Research, and Annotated Bibliography.
- Bicchieri, C., 2006. *The grammar of society. The Nature and Dynamics of Social Norms*: Cambridge University Press, New York, New York.
- Bicchieri, C. and Muldoon, R., 2014. Social Norms: *Stanford Encyclopedia of Philosophy*.
- Blasch, J. and Ohndorf, M., 2015. Altruism, moral norms and social approval: Joint

- determinants of individual offset behavior: *Ecological Economics*, **116**, p. 251–260.
- Blash, J., 2015. Doing Good or Undoing Harm - Framing Voluntary Contributions to Climate Change Mitigation. In: *EAERE Conference, Helsinki* p. 31p.
- 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**, p. 135–153.
- Borsari, B. and Carey, K.B., 2003. Descriptive and Injunctive Norms in College Drinking: A Meta- Analytic Integration: *Journal of Alcohol Studies*, **64**, p. 331–341.
- Bougherara, D. and Ducos, G., 2006. Farmers' preferences over compensation contract flexibility and duration: an estimation of the effect of transaction costs using choice experiment. In: *Ière Journée de l'European School on New-Institutional Economics* Université de Paris-Sud XI.
- Bratt, C., 1999. The Impact of Norms and Assumed Consequences on Recycling Behavior: *Environment and Behavior*, **31**, p. 630–656.
- Brewer, M.B. and Kramer, R.M., 1986. Choice behavior in social dilemmas: Effects of social identity, group size, and decision framing.: *Journal of personality and social psychology*, **50**, p. 543.
- Broch, S.W. and Vedel, S.E., 2012. Using Choice Experiments to Investigate the Policy Relevance of Heterogeneity in Farmer Agri-Environmental Contract Preferences: *Environmental and Resource Economics*, **51**, p. 561–581.
- Brotherton, I., 1991. What limits participation in ESAs? *Journal of Environmental Management*, **32**, p. 241–249.
- Bull, J.W., Suttle, K.B., Gordon, A., Singh, N.J. and Milner-Gulland, E.J., 2013a. Biodiversity offsets in theory and practice: *Oryx*, **47**, p. 369–380.
- Bull, J.W., Suttle, K.B., Singh, N.J. and Milner-Gulland, E.J., 2013b. Conservation when nothing stands still: Moving targets and biodiversity offsets: *Frontiers in Ecology and the Environment*, **11**, p. 203–210.
- Bulte, E., Gerking, S., List, J. a. and De Zeeuw, A., 2005. The effect of varying the causes of environmental problems on stated WTP values: Evidence from a field study: *Journal of Environmental Economics and Management*, **49**, p. 330–342.
- Burton, R.J.F., 2004a. Reconceptualising the 'behavioural approach' in agricultural studies: A socio-psychological perspective: *Journal of Rural Studies*, **20**, p. 359–371.
- Burton, R.J.F., 2004b. Seeing Through the 'Good Farmer's' Eyes: Towards Developing an Understanding of the Social Symbolic Value of 'Productivist' Behaviour: *Sociologia Ruralis*, **44**, p. 195–215.
- Burton, R.J.F. and Schwarz, G., 2013. Result-oriented agri-environmental schemes in Europe and their potential for promoting behavioural change: *Land Use Policy*, **30**, p. 628–641.
- Cadsby, C.B., Croson, R., Marks, M. and Maynes, E., 2007. Step return versus net reward in the voluntary provision of a threshold public good: An adversarial collaboration: *Public*

- Choice*, **135**, p. 277–289.
- Cadsby, C.B. and Maynes, E., 1999. Voluntary provision of threshold public goods with continuous contributions: experimental evidence: *Journal of Public Economics*, **71**, p. 53–73.
- Carli, L.L., Ganley, R. and Pierce-Otay, A., 1991. Similarity and Satisfaction in Roommate Relationships: *Personality and Social Psychology Bulletin*, **17**, p. 419–426.
- Carr, S. and Tait, J., 1991. Differences in the attitudes of farmers and conservationists and their implications: *Journal of Environmental Management*, **32**, p. 281–294.
- CEN-LR, COGARD, CHAMBRE D'AGRICULTURE and SAFER-LR, 2013. Mise en œuvre de mesures compensatoires en faveur de l'Outarde canepetière dans la ZPS Costières nîmoises – Rapport final du programme 2009-2013..
- Chabé-Ferret, S. and Subervie, J., 2013. How much green for the buck? Estimating additional and windfall effects of French agro-environmental schemes by DID-matching: *Journal of Environmental Economics and Management*, **65**, p. 13–27.
- Chen, X., Lupi, F., He, G. and Liu, J., 2009. Linking social norms to efficient conservation investment in payments for ecosystem services: *Proceedings of the National Academy of Sciences of the United States of America*, **106**, p. 11812–7.
- Choe, C. and Fraser, I., 1999. Compliance Monitoring and Agri-Environmental Policy: *Journal of Agricultural Economics*, **50**, p. 468–487.
- Christensen, T., Pedersen, A.B., Nielsen, H.O., Mørkbak, M.R., Hasler, B. and Denver, S., 2011. Determinants of farmers' willingness to participate in subsidy schemes for pesticide-free buffer zones-A choice experiment study: *Ecological Economics*, **70**, p. 1558–1564.
- Cialdini, R.B., 2007. Descriptive social norms as underappreciated sources of social control: *Psychometrika*, **72**, p. 263–268.
- Cialdini, R.B., Demaine, L.J., Sagarin, B.J., Barrett, D.W., Rhoads, K. and Winter, P.L., 2006. Managing social norms for persuasive impact: *Social Influence*, **1**, p. 3–15.
- Cialdini, R.B., Reno, R.R. and Kallgren, C.A., 1990. A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places: *Journal of personality and Social Psychology*, **58**, p. 1015–1026.
- Cialdini, R. and Trost, M., 1998. Social influence: Social norms, conformity and compliance.: *The Handbook of Social Psychology*, **2**, p. 151–192.
- Claassen, R., Cattaneo, A. and Johansson, R., 2008. Cost-effective design of agri-environmental payment programs: U.S. experience in theory and practice: *Ecological Economics*, **65**, p. 737–752.
- Le Coent, P., Préget, R. and Thoyer, S., 2014. Why pay for nothing? An experiment on a conditional subsidy scheme in a threshold public good game.: *Economics Bulletin*, **34**, p. 1976–1989.
- Colen, L., Paloma, S., Latacz-Lohmann, U., Lefebvre, M., Préget, R. and Thoyer, S., 2016.

- Economic experiments as a tool for agricultural policy evaluation: insights from the European CAP: *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie*, p. In press.
- Collier, A., Cotterill, A., Everett, T., Muckle, R., Pike, T. and Vanstone, A., 2010. Understanding and influencing behaviours: A review of social research, economics and policy making in Defra:.
- Conner, M. and Armitage, C.J., 1998. Extending the Theory of Planned Behavior: A Review and Avenues for Further Research: *Journal of Applied Social Psychology*, **28**, p. 1429–1464.
- Calvet, C., Guillaume, O. and Claude, N., 2015. Tracking the origins and development of biodiversity offsetting in academic research and its implications for conservation: A review: *Biological Conservation*, **192**, p. 492–503.
- Crocker, T.D., Shogren, J.F. and Turner, P.R., 1998. Incomplete beliefs and nonmarket valuation: *Resource and Energy Economics*, **20**, p. 139–162.
- Croson, R., Handy, F. and Shang, J., 2009. Keeping up with the Joneses: The relationship of perceived descriptive social norms, social information, and charitable giving: *Nonprofit Management and Leadership*, **19**, p. 467–489.
- Croson, R.T. a. and Marks, M.B., 2000. Step returns in threshold public goods: A meta- and experimental analysis: *Experimental Economics*, **2**, p. 239–259.
- Croson, R. and Shang, J., 2008. The impact of downward social information on contribution decisions: *Experimental Economics*, **11**, p. 221–233.
- Croson, R. and Treich, N., 2014. Behavioral Environmental Economics: Promises and Challenges: *Environmental and Resource Economics*, p. 1–20.
- Cummings, R.G., Brookshire, D.S., Bishop, R.C. and Arrow, K.J., 1986. *Valuing environmental goods: an assessment of the contingent valuation method*: Rowman & Littlefield Pub Incorporated.
- Darnton, A., 2008. An overview of behaviour change models and their uses:.
- Davenport, J. and Davenport, J.L., 2006. *The ecology of transportation: managing mobility for the environment* (J. Davenport and J. L. Davenport, Eds.): Springer Netherlands.
- Dawes, R. and Orbell, J., 1986. Organizing groups for collective action: *The American Political Science Review*, **80**, p. 1171–1185.
- DEFRA, 2005. Securing the future delivering UK sustainable development strategy:.
- Defra, 2008. Understanding behaviours in a farming context: *Defra Agricultural Change and Environment Observatory Discussion Paper*.
- Defrancesco, E., Gatto, P., Runge, F. and Trestini, S., 2008. Factors affecting farmers' participation in agri-environmental measures: A northern Italian perspective: *Journal of Agricultural Economics*, **59**, p. 114–131.
- Delvaux, L., Henry de Frahan, B., Dupraz, P. and Vermersch, D., 1999. Adoption d'une MAE et consentement à recevoir des agriculteurs en région wallone: *Économie rurale*, **249**, p.

71–81.

- Derissen, S. and Quaas, M.F., 2013. Combining performance-based and action-based payments to provide environmental goods under uncertainty: *Ecological Economics*, **85**, p. 77–84.
- Devoucoux, P., 2014. Conséquences et impacts prévisibles d'une perte d'habitat majeure sur une espèce menacée aux exigences écologiques complexes: Effets de la mise en place du Contournement ferroviaire à grande vitesse Nîmes-Montpellier sur la dynamique de la population d'Ou: Université de Poitiers, 217 p.
- Dhar, R., 1997. Consumer preference for a No Choice option: *Journal of Consumer Research*, **24**, p. 215–231.
- Dhar, R. and Simonson, I., 2003. The Effect of Forced Choice on Choice: *Journal of Marketing Research*, **40**, p. 146–160.
- Dobbs, T.L. and Pretty, J., 2008. Case study of agri-environmental payments: The United Kingdom: *Ecological Economics*, **65**, p. 765–775.
- Drake, L., Bergström, P. and Svedsäter, H., 1999. Farmers' attitudes and uptake. In: *Countryside Stewardship: Farmers, Policies and Markets*. Oxford: Elsevier Science Ltd (Van Huylenbroeck, G., and Whitby, M., eds.) ELSEVIER SCI LTD, p. 89–111.
- Drechsler, M., Wätzold, F., Johst, K. and Shogren, J.F., 2010. An agglomeration payment for cost-effective biodiversity conservation in spatially structured landscapes: *Resource and Energy Economics*, **32**, p. 261–275.
- Ducos, G. and Dupraz, P., 2007. The asset specificity issue in the private provision of environmental services: Evidence from agri-environmental contracts. In: *8th International Meeting of the Association for Public Economy Theory, Vanderbilt University, Nashville* p. 25 p.
- 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**, p. 669–687.
- Dunlap, R.E. and Van Liere, K.D., 1978. The new ecological paradigm: *Journal of environmental education*, **9**, p. 10–19.
- Dupraz, P., Latouche, K. and Turpin, N., 2007. Programmes agri-environnementaux en présence d'effets de seuil: *Cahiers d'Economie et Sociologie Rurales*, **82-83**, p. 5–32.
- Eagly, A.H. and Chaiken, S., 1993. *The psychology of attitudes.*: Harcourt Brace Jovanovich College Publishers, Orlando, FL, US.
- Elster, J., 1989. Social Norms and Economic Theory: *The Journal of Economic Perspectives*, **3**, p. 99–117.
- Engel, S., Pagiola, S. and Wunder, S., 2008. Designing payments for environmental services in theory and practice: An overview of the issues: *Ecological economics*, **65**, p. 822–833.
- Envilys, 2013. Etude diagnostic de la pollution du captage d'Espira de l'Agly par les produits phytosanitaires et élaboration d'un plan d'actions.

- Espinosa-Goded, M., Barreiro-Hurlé, J. and Ruto, E., 2010. What Do Farmers Want From Agri-Environmental Scheme Design? A Choice Experiment Approach: *Journal of Agricultural Economics*, **61**, p. 259–273.
- Etrillard, C. and Pech, M., 2015. Mesures de compensation écologique: risques ou opportunités pour le foncier agricole en France? *VertigO-la revue électronique en sciences de l'environnement*, **15**.
- Falconer, K., 2000a. Farm-level constraints on agri-environmental scheme participation: a transactional perspective: *Journal of Rural Studies*, **16**, p. 379–394.
- Ferraro, P.J., 2008. Asymmetric information and contract design for payments for environmental services: *Ecological Economics*, **65**, p. 810–821.
- Fielding, K.S., Terry, D.J., Masser, B.M., Bordia, P. and Hogg, M.A., 2005. Explaining landholders' decisions about riparian zone management: the role of behavioural, normative, and control beliefs.: *Journal of environmental management*, **77**, p. 12–21.
- Fischbacher, U. and Gächter, S., 2010. Social Preferences, Beliefs, and the Dynamics of Free Riding in Public Goods Experiments: *The American Economic Review*, **100**, p. 541–556 .
- Fischer, P. and Huddart, S., 2008. A Optimal Contracting with Endogenous Social Norms : *The American Economic Review*, **98**, p. 1459–1475.
- Fishbein, M. and Ajzen, I., 1975. *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research*.
- Fleishman, J.A., 1988. The effects of decision framing and others' behavior on cooperation in a social dilemma: *Journal of Conflict Resolution*, **32**, p. 162–180.
- Forman, R.T.T., 1995. Some general principles of landscape and regional ecology: *Landscape Ecology*, **10**, p. 133–142.
- Fraser, R., 2009. Land Heterogeneity, Agricultural Income Forgone and Environmental Benefit: An Assessment of Incentive Compatibility Problems in Environmental Stewardship Schemes: *Journal of Agricultural Economics*, **60**, p. 190–201.
- Fraser, R., 2002. Moral Hazard and Risk Management in Agri-environmental Policy: *Journal of Agricultural Economics*, **53**, p. 475–487.
- Fraser, R., 2004. On the Use of Targeting to Reduce Moral Hazard in Agri-environmental Schemes: *Journal of Agricultural Economics*, **55**, p. 525–540.
- French, D.P. and Hankins, M., 2003. The expectancy-value muddle in the theory of planned behaviour - and some proposed solutions: *British Journal of Health Psychology*, **8**, p. 37–55.
- Frey, B.S. and Meier, S., 2004. Social Comparisons and Pro-Social Behavior: Testing 'Conditional Cooperation' in a Field Experiment: *The American Economic Review*, **94**, p. 1717 – 1722.
- Giger, J.C., 2008. Examen critique du caractère prédictif, causal et falsifiable de deux théories de la relation attitude-comportement : la théorie de l'action raisonnée et la théorie du comportement planifié: *Annee Psychologique*, **108**, p. 107–131.

- Goldman, R.L., Thompson, B.H. and Daily, G.C., 2007. Institutional incentives for managing the landscape: Inducing cooperation for the production of ecosystem services: *Ecological Economics*, **64**, p. 333–343.
- Goldstein, N.J., Cialdini, R.B. and Griskevicius, V., 2008. A Room with a Viewpoint: Using Social Norms to Motivate Environmental Conservation in Hotels: *Journal of Consumer Research*, **35**, p. 472–482.
- Gregory, R., Lichtenstein, S. and MacGregor, D., 1993. The Role of Past States in Determining Reference Points for Policy Decisions: *Organizational Behavior and Human Decision Processes*, **55**, p. 195–206.
- Haaijer, R., Kamakura, W. and Wedel, M., 2001. The ‘no-choice’ alternative in conjoint choice experiments: *International Journal of Market Research*, **43**, p. 93–106.
- Hanley, N., Whitby, M. and Simpson, I., 1999. Assessing the success of agri-environmental policy in the UK: *Land Use Policy*, **16**, p. 67–80.
- Hardeman, W., Johnston, M., Johnston, D., Bonetti, D., Wareham, N. and Kinmonth, A.L., 2002. Application of the Theory of Planned Behaviour in Behaviour Change Interventions: A Systematic Review: *Psychology & Health*, **17**, p. 123–158.
- Hausman, J. and McFadden, D., 1984. Specification Tests for the Multinomial Logit Model: *Econometrica*, **52**, p. 1219.
- Heath, Y. and Gifford, R., 2006. Free-Market Ideology and Environmental Degradation: The Case of Belief in Global Climate Change: *Environment and Behavior*, **38**, p. 48–71.
- Heberlein, T. a, 1972. The Land Ethic Realized: Some Social Psychological Explanations for Changing Environmental Attitudes: *Journal of Social Issues*, **28**, p. 79–87.
- Hessing, D.J., Elffers, H. and Weigel, R.H., 1988. Exploring the limits of self-reports and reasoned action: An investigation of the psychology of tax evasion behavior.: *Journal of personality and social psychology*, **54**, p. 405.
- Hodge, I., 2013. Agri-environment policy in an era of lower government expenditure: CAP reform and conservation payments: *Journal of Environmental Planning and Management*, **56**, p. 254–270.
- Hopper, J.R. and McCarlnielsen, J., 1991. Recycling as altruistic behavior: Normative and Behavioral strategies to expand participation in a community recycling program: *Environment and be*, **23**, p. 195–220.
- Huber, J. and Zwerina, K., 1996. The Importance of Utility Balance in Efficient Choice Designs: *Journal of Marketing Research*, **33**, p. 307–317.
- Isaac, R., Schmitz, D. and Walker, J., 1989. The assurance problem in a laboratory market: *Public Choice*, **62**, p. 217–236.
- Jacob, C., Quétier, F., Aronson, J., Pioch, S. and Levrel, H., 2015. Vers une politique française de compensation des impacts sur la biodiversité plus efficace : défis et perspectives: <http://vertigo.revues.org>.
- Kahneman, D., 2003. A psychological perspective on economics: *The American economic*

- review, **93**, p. 162–168.
- Kahneman, D., Ritov, I., Jacowitz, K.E. and Grant, P., 1993. Stated Willingness to Pay for Public Goods: A Psychological Perspective: *Psychological Science*, **4**, p. 310–315.
- Kahneman, D. and Tversky, A., 1979. Prospect Theory: an Analysis of Decision Under Risk: *Econometrica*, **66**, p. 497–527.
- Karsenty, A., Sembres, T. and Randrianarison, M., 2010. Paiements pour services environnementaux et biodiversité dans les pays du sud: *Revue Tiers Monde*, **2**, p. 57–74.
- Kellstedt, P.M., Zahran, S. and Vedlitz, A., 2008. Personal Efficacy, the Information Environment, and Attitudes Toward Global Warming and Climate Change in the United States: *Risk Analysis*, **28**, p. 113–126.
- Kimbrough, E.O. and Vostroknutov, A., 2013. Norms Make Preferences Social: *SSRN Electronic Journal*.
- Kontoleon, A. and Yabe, M., 2003. Assessing the Impacts of Alternative ‘Opt-out’ Formats in Choice Experiment Studies: Consumer Preferences for Genetically Modified Content and Production Information in Food: *Journal of Agricultural Policy Research*, p. 1–43.
- Kuhfuss, L., Le Coent, P., Préget, R. and Thoyer, S., 2015. Agri-Environmental Schemes in Europe: Switching to Collective Action. In: *Protecting the Environment, Privately* (Bennett, J., ed.) World Scientific Publishing - Imperial College Press, p. 200.
- Kuhfuss, L., Jacquet, F., Préget, R. and Thoyer, S., 2013. Le dispositif des MAEt pour l’ enjeu eau : une fausse bonne idée ? *Review of Agricultural and Environmental Studies*, **93**, p. 395–422.
- Kuhfuss, L., Preget, R. and Thoyer, S., 2014. Préférences individuelles et incitations collectives : quels contrats agroenvironnementaux pour la réduction des herbicides par les viticulteurs ? *Revue d’Études en Agriculture et Environnement*, **95**, p. 111–143.
- Kuhfuss, L., Préget, R., Thoyer, S., Hanley, N., Le Coent, P. and Désolé, M., 2016. Nudges, social norms and permanence in agri-environmental schemes: *Land Economics*, **92**, p. 641–655.
- Kuhfuss, L. and Subervie, J., 2015. Do agri-environmental schemes help reduce herbicide use ? Evidence from a natural experiment in France: DR n°2015-02.
- Lamine, C., 2011. Anticiper ou temporiser : injonctions environnementales et recompositions des identités professionnelles en céréaliculture: *Sociologie du Travail*, **53**, p. 75–92.
- Lancaster, K.J., 1966. A new approach to consumer theory: *The journal of political economy*, **74**, p. 132–157.
- Latacz-Lohmann, U. and Van der Hamsvoort, C., 1997. Auctioning Conservation Contracts: A Theoretical Analysis and an Application: *American Journal of Agricultural Economics*, **79**, p. 407–418.
- Latacz-Lohmann, U. and Webster, P., 1998. Moral hazard in agri-environmental schemes. In: *Agricultural Economics Society Annual Conference, Reading* p. 25–28.
- Ledyard, J., 1995. Public goods: A survey of experimental research. In: *The handbook of*

- experimental economics* (Kagel, J., and Roth, A., eds.) Princeton University Press, Princeton, NJ.
- De Leeuw, A., Valois, P., Ajzen, I. and Schmidt, P., 2015. Using the theory of planned behavior to identify key beliefs underlying pro-environmental behavior in high-school students: Implications for educational interventions: *Journal of Environmental Psychology*, **42**, p. 128–138.
- Levin, I.P., Schneider, S.L. and Gaeth, G.J., 1998. All Frames Are Not Created Equal: A Typology and Critical Analysis of Framing Effects: *Organizational Behavior and Human Decision Processes*, **76**, p. 149–188.
- Liere, K.D. Van and Dunlap, R.E., 1978. Moral Norms and Environmental Behavior: An Application of Schwartz's Norm-Activation Model to Yard Burning: *Journal of Applied Social Psychology*, **8**, p. 174–188.
- Lindbeck, A., Nyberg, S. and Weibull, J.W., 1999. Social norms and economic incentives in the welfare state: *Quarterly Journal of Economics*, **114**, p. 1–35.
- Litvine, D., 2008. Révélation des préférences individuelles et incitation au choix de l'électricité verte: Une analyse de la décision du consommateur: Montpellier, 411 p.
- Litvine, D. and Wüstenhagen, R., 2011. Helping 'light green' consumers walk the talk: Results of a behavioural intervention survey in the Swiss electricity market: *Ecological Economics*, **70**, p. 462–474.
- Lokhorst, A.M., Staats, H., van Dijk, J., van Dijk, E. and de Snoo, G., 2011. What's in it for Me? Motivational Differences between Farmers' Subsidised and Non-Subsidised Conservation Practices: *Applied Psychology*, **60**, p. 337–353.
- Louis, M. and Rousset, S., 2010. Coûts de transaction et adoption des contrats agroenvironnementaux Le cas des MAE territorialisées à enjeu DCE en Poitou-Charentes. In: *Colloque SFER Cemagref* p. 27 p.
- Lynne, G., 1995. Modifying the neo-classical approach to technology adoption with behavioral science models: *Journal of Agricultural and Applied economics*, **27**, p. 67–80.
- Lynne, G.D., Franklin Casey, C., Hodges, A. and Rahmani, M., 1995. Conservation technology adoption decisions and the theory of planned behavior: *Journal of Economic Psychology*, **16**, p. 581–598.
- Macgregor, C.J. and Warren, C.R., 2006. Adopting sustainable farm management practices within a Nitrate Vulnerable Zone in Scotland: The view from the farm: *Agriculture, Ecosystems and Environment*, **113**, p. 108–119.
- Manning, M., 2009. The effects of subjective norms on behaviour in the theory of planned behaviour: a meta-analysis.: *The British journal of social psychology / the British Psychological Society*, **48**, p. 649–705.
- Manski, C.F., 2000. Economic Analysis of Social Interactions: *Journal of Economic Perspectives*, **14**, p. 115–136.
- Manstead, A.S.R. and others, 1996. Attitudes and behaviour: *Applied social psychology*, p. 3–29.

- Marks, M. and Croson, R., 1998. Alternative rebate rules in the provision of a threshold public good: An experimental investigation: *Journal of Public Economics*, **67**, p. 195–220.
- Maron, M., Bull, J.W., Evans, M.C. and Gordon, A., 2015. Locking in loss: Baselines of decline in Australian biodiversity offset policies: *Biological Conservation*, **192**, p. 504–512.
- Matzdorf, B. and Lorenz, J., 2010. How cost-effective are result-oriented agri-environmental measures?—An empirical analysis in Germany: *Land Use Policy*, **27**, p. 535–544.
- McCullagh, P., 1988. Regression models for ordinal data: *Journal of the royal statistical society. Series B (Methodological)*, p. 109–142.
- McFadden, D., 1974. Conditional logit analysis of qualitative choice behavior: *Frontiers in Econometrics*, p. 105–142.
- McFadden, D. and Train, K., 2000. Mixed MNL models for discrete response: *Journal of Applied Econometrics*, **15**, p. 447–470.
- McKenney, B.A. and Kiesecker, J.M., 2010. Policy Development for Biodiversity Offsets: A Review of Offset Frameworks: *Environmental Management*, **45**, p. 165–176.
- McLeod, S., 2007. *Simply Psychology*.
- Mellström, C. and Johannesson, M., 2008. Crowding Out in Blood Donation: Was Titmuss Right? *Journal of the European Economic Association*, **6**, p. 845–863.
- Morris, C. and Potter, C., 1995. Recruiting the new conservationists: Farmers' adoption of agri-environmental schemes in the U.K.: *Journal of Rural Studies*, **11**, p. 51–63.
- Moxey, A., White, B. and Ozanne, A., 2008. Efficient Contract Design for Agri-Environment Policy: *Journal of Agricultural Economics*, **50**, p. 187–202.
- Mullainathan, S. and Thaler, R.H., 2000. Behavioral Economics: *The National Bureau of Economic Research Working Paper Series*.
- Muñoz-Piña, C., Guevara, A., Torres, J.M. and Braña, J., 2008. Paying for the hydrological services of Mexico's forests: Analysis, negotiations and results: *Ecological Economics*, **65**, p. 725–736.
- Munshi, K. and Myaux, J., 2006. Social norms and the fertility transition: *Journal of Development Economics*, **80**, p. 1–38.
- Muradian, R., 2001. Ecological thresholds: a survey: *Ecological economics*, **38**, p. 7–24.
- Murray, D.M., Johnson, C.A., Luepker, R. V. and Mittelmark, M.B., 1984. The Prevention of Cigarette Smoking in Children: A Comparison of Four Strategies1: *Journal of Applied Social Psychology*, **14**, p. 274–288.
- Mzoughi, N., 2011. Farmers adoption of integrated crop protection and organic farming: Do moral and social concerns matter? *Ecological Economics*, **70**, p. 1536–1545.
- Nolan, J.M., Schultz, P.W., Cialdini, R.B., Goldstein, N.J. and Griskevicius, V., 2008. Normative social influence is underdetected.: *Personality & social psychology bulletin*,

34, p. 913–23.

- Norman, G., 2010. Likert scales, levels of measurement and the ‘laws’ of statistics: *Advances in Health Sciences Education*, **15**, p. 625–632.
- Nyborg, K., 2010. Will green taxes undermine moral motivation? *Public Finance and Management*, **10**, p. 331–351.
- Nyborg, K., Howarth, R.B. and Brekke, K.A., 2006. Green consumers and public policy: On socially contingent moral motivation: *Resource and Energy Economics*, **28**, p. 351–366.
- ODA, 2005. The Conservation Reserve Enhancement Program.
- Osgood, C.E., 1952. The nature and measurement of meaning.: *Psychological bulletin*, **49**, p. 197.
- Ostrom, E., 2006. The value-added of laboratory experiments for the study of institutions and common-pool resources: *Journal of Economic Behavior and Organization*, **61**, p. 149–163.
- Oullier, O. and Sauneron, S., 2011. Green nudges: New incentives for ecological behaviours:.
- Ozanne, A., Hogan, T. and Colman, D., 2001. Moral hazard, risk aversion and compliance monitoring in agri- environmental policy: *European Review of Agricultural Economics*, **28**, p. 329–348.
- Pagiola, S., 2008. Payments for environmental services in Costa Rica: *Ecological Economics*, **65**, p. 712–724.
- Parker, D., Manstead, A.S.R. and Stradling, S.G., 1995. Extending the theory of planned behaviour: The role of personal norm: *British Journal of Social*, **34**, p. 127–137.
- Parkhurst, G.M. and Shogren, J.F., 2007. Spatial incentives to coordinate contiguous habitat: *Ecological Economics*, **64**, p. 344–355.
- Parkhurst, G.M., Shogren, J.F., Bastian, C., Kivi, P., Donner, J. and Smith, R.B.W., 2002. Agglomeration bonus: an incentive mechanism to reunite fragmented habitat for biodiversity conservation: *Ecological Economics*, **41**, p. 305–328.
- Peerlings, J. and Polman, N., 2009. Farm choice between agri-environmental contracts in the European Union: *Journal of Environmental Planning and Management*, **52**, p. 593–612.
- Perrings, C. and Pearce, D., 1994. Threshold effects and incentives for the conservation of biodiversity: *Environmental & Resource Economics*, **4**, p. 13–28.
- Van der Pligt, J., Zeelenberg, M., Van Dijk, W.W., De Vries, N.K. and Richard, R., 2011. Affect, Attitudes and Decisions: Let’s Be More Specific: *European Review of Social Psychology*, **8**, p. 33–36.
- Quétier, F., Moura, C., Menut, T., Boulnois, R. and Rufay, X., 2015. La compensation écologique fonctionnelle : innover pour mieux traiter les impacts résiduels des projets d’aménagements sur la biodiversité: *Sciences, Eaux et Territoires*, **17**, p. 24–28.
- Quétier, F., Regnery, B. and Levrel, H., 2014. No net loss of biodiversity or paper offsets? A critical review of the French no net loss policy: *Environmental Science & Policy*, **38**, p.

120–131.

- Quintero, J.D. and Mathur, A., 2011. Biodiversity offsets and infrastructure.: *Conservation biology : the journal of the Society for Conservation Biology*, **25**, p. 1121–1123.
- Rapoport, A. and Eshed-Levy, D., 1989. Provision of step-level public goods: Effects of greed and fear of being gypped: *Organizational Behavior and Human Decision Processes*, **44**, p. 325–344.
- Rege, M., 2004. Social Norms and Private Provision of Public Goods: *Journal of Public Economic Theory*, **6**, p. 65–77.
- Rege, M. and Telle, K., 2004. The impact of social approval and framing on cooperation in public good situations: *Journal of Public Economics*, **88**, p. 1625–1644.
- Rivis, A. and Sheeran, P., 2003. Descriptive norms as an additional predictor in the theory of planned behaviour: A meta-analysis: *Current Psychology*, **22**, p. 218–233.
- Rondeau, D., Poe, G.L. and Schulze, W.D., 2005. VCM or PPM? A comparison of the performance of two voluntary public goods mechanisms: *Journal of Public Economics*, **89**, p. 1581–1592.
- Rørstad, P.K., Vatn, A. and Kvakkestad, V., 2007. Why do transaction costs of agricultural policies vary? *Agricultural Economics*, **36**, p. 1–11.
- Runge, C., 1984. Institutions and the free rider: The assurance problem in collective action: *The Journal of Politics*, **46**.
- Ruto, E. and Garrod, G., 2009. Investigating farmers' preferences for the design of agri-environment schemes: a choice experiment approach: *Journal of Environmental Planning and Management*, **52**, p. 631–647.
- Scemama, P. and Levrel, H., 2014. L'émergence du marché de la compensation aux États-Unis: changements institutionnels et impacts sur les modes d'organisation et les caractéristiques des transactions: *Revue d'Economie Politique*, **123**, p. 1–32.
- Schroeder, C.M. and Prentice, D. a, 1998. Exposing Pluralistic Ignorance to Reduce Alcohol Use Among College Students: *Journal of Applied Social Psychology*, **28**, p. 2150–2180.
- Schubert, C., 2016. Green nudges: Do they work? Are they ethical? *Joint Discussion Paper Series in Economics* 09-2016.
- Schultz, P.W., Nolan, J.M., Cialdini, R.B., Goldstein, N.J. and Griskevicius, V., 2007. The constructive, destructive, and reconstructive power of social norms.: *Psychological science*, **18**, p. 429–34.
- Schwartz, S.H., 1977. Normative Influences on Altruism: *Advances in Experimental Social Psychology*, **10**, p. 221–279.
- Schwartz, S.H. and Fleishman, J.A., 1978. Personal norms and the mediation of legitimacy effects on helping: *Social Psychology*, **41**, p. 306–315.
- Seagle, C., 2012. Inverting the impacts: Mining, conservation and sustainability claims near the Rio Tinto/QMM ilmenite mine in Southeast Madagascar.

- Segerson, K., 1988. Uncertainty and incentives for nonpoint pollution control: *Journal of Environmental Economics and Management*, **15**, p. 87–98.
- Sen, A., 1967. Isolation, assurance and the social rate of discount: *The Quarterly Journal of Economics*, **81**, p. 112–124.
- Shang, J. and Croson, R., 2009. A field experiment in charitable contribution: The impact of social information on the voluntary provision of public goods: *The Economic Journal*, **119**, p. 1422–1439.
- Shogren, J.F., Parkhurst, G.M. and Banerjee, P., 2010. Two cheers and a qualm for behavioral environmental economics: *Environmental and Resource Economics*, **46**, p. 235–247.
- Shogren, J.F. and Taylor, L.O., 2008. On Behavioral-Environmental Economics: *Review of Environmental Economics and Policy*, **2**, p. 26–44.
- Slangen, L., 1997. How to organise nature protection by farmers: *European Review of Agricultural Economics*, **24**, p. 508–529.
- Solagro, 2013. Etude de faisabilité des Engagements Unitaires à IFT modifiés. Rapport d'Etude pour l'INRA.
- Sommerville, M., Milner-Gulland, E.J., Rahajaharison, M. and Jones, J.P.G., 2010. Impact of a community-based payment for environmental services intervention on forest use in Menabe, Madagascar.: *Conservation biology: the journal of the Society for Conservation Biology*, **24**, p. 1488–98.
- Sonnemans, J., Schram, A. and Offerman, T., 1998. Public good provision and public bad prevention: The effect of framing: *Journal of Economic Behavior & Organization*, **34**, p. 143–161.
- Sparks, P., Guthrie, C. a and Shepherd, R., 1997. The Dimensional Structure of the Perceived Behavioral Control Construct: *Journal of Applied Social Psychology*, **27**, p. 418–438.
- Spencer, M. a., Swallow, S.K., Shogren, J.F. and List, J. a., 2009. Rebate rules in threshold public good provision: *Journal of Public Economics*, **93**, p. 798–806.
- Staats, H., Jansen, L. and Thøgersen, J., 2011. Greening the greenhouse grower. A behavioral analysis of a sector-initiated system to reduce the environmental load of greenhouses: *Journal of Environmental Management*, **92**, p. 2461–2469.
- Stern, P.C., Dietz, T., Abel, T., Guagnano, G.A. and Kalof, L., 1999. A value-belief-norm theory of support for social movements: The case of environmentalism: *Human Ecology Review*, **6**, p. 81–97.
- Stutzer, A. and Lalive, R., 2004. The Role of Social Work Norms in Job Searching and Subjective Well-Being: *Journal of the European Economic Association*, **2**, p. 696–719.
- Suleiman, R. and Rapoport, A., 1992. Provision of step-level public goods with continuous contribution: *Journal of Behavioral Decision Making*, **5**, p. 133–153.
- Sumpsi, J., Iglesias, E., Garrido, A., Dabbert, S., Dubgaard, A., Slangen, L., Whitby, M. and others, 1998. An integrated approach to agricultural and environmental policies: a case-study of the Spanish cereal sector. *The economics of landscape and wildlife*

- conservation.*, p. 239–251.
- Sunstein, C.R., 1996. Social Norms and Social Roles: *Columbia Law Review*, **96**, p. 903.
- Sunstein, C.R. and Savourey, E., 2015. Intégrer les sciences comportementales dans les politiques publiques: *Le Monde*,.
- Thaler, R.H. and Sunstein, C.R., 2008. *Nudge: Improving Decisions About Health, Wealth, and Happiness*: Yale University Press.
- Thøgersen, J., 2006. Norms for environmentally responsible behaviour: An extended taxonomy: *Journal of Environmental Psychology*, **26**, p. 247–261.
- Thøgersen, J., 2014. The Mediated Influences of Perceived Norms on Pro-environmental Behavior: *Revue D Economie Politique*, **124**, p. 179–193.
- Titmuss, R.M., 1970. The gift relationship: *London*, **19**, p. 70.
- Train, K., 2009. *Discrete Choice Methods with Simulation*: Cambridge University Press.
- Turaga, R.M.R., Howarth, R.B. and Borsuk, M.E., 2010. Pro-environmental behavior: rational choice meets moral motivation.: *Annals of the New York Academy of Sciences*, **1185**, p. 211–24.
- Tversky, A. and Kahneman, D., 1991. Loss Aversion in Riskless Choice: A Reference-Dependent Model: *The Quarterly Journal of Economics*, **106**, p. 1039–1061.
- Tversky, A. and Shafir, E., 1992. Choice under conflict: The dynamics of deferred decision: *Psychological Science*, **3**, p. 358–361.
- University of Reading, 2006. Behaviour and motivations of farmers in responding to policy changes in England:.
- Vanslebrouck, I., Van Huylenbroeck, G. and Verbeke, W., 2002a. Determinants of the Willingness of Belgian Farmers to Participate in Agri-environmental Measures: *Journal of Agricultural Economics*, **53**, p. 489–511.
- Vatn, A., 2010. An institutional analysis of payments for environmental services: *Ecological Economics*, **69**, p. 1245–1252.
- Vella, F., 1998. Estimating Models with Sample Selection Bias: A Survey: *The Journal of Human Resources*, **33**, p. 127–169.
- Vermeulen, B., Goos, P. and Vandebroek, M., 2008. Models and optimal designs for conjoint choice experiments including a no-choice option: *International Journal of Research in Marketing*, **25**, p. 94–103.
- Verplanken, B., Aarts, H., Van Knippenberg, A. and Moonen, A., 1998. Habit versus planned behaviour: A field experiment: *British Journal of Social Psychology*, **37**, p. 111–128.
- Villanueva, A.J., Gomez-Limon, J.A., Arriaza, M. and Rodriguez-Entrena, M., 2015. The design of agri-environmental schemes: Farmers' preferences in southern Spain: *Land Use Policy*, **46**, p. 142–154.
- Vining, J. and Ebreo, a, 1992. Predicting Recycling Behavior From Global and Specific

- Environmental Attitudes and Changes in Recycling Opportunities: *Journal of Applied Social Psychology*, **22**, p. 1580–1607.
- Walker, M.E., Morera, O.F., Vining, J. and Orland, B., 1999. Disparate WTA WTP Disparities: The Influence of Human versus Natural Causes: *Journal of Behavioral Decision Making*, **12**, p. 219–232.
- Warziniack, T., Shogren, J.F. and Parkhurst, G., 2007. Creating contiguous forest habitat: An experimental examination on incentives and communication: *Journal of Forest Economics*, **13**, p. 191–207.
- Wauters, E., Bielders, C., Poesen, J., Govers, G. and Mathijs, E., 2010. Adoption of soil conservation practices in Belgium: An examination of the theory of planned behaviour in the agri-environmental domain: *Land Use Policy*, **27**, p. 86–94.
- White, K.M., Hogg, M.A. and Terry, D.J., 2010. Improving Attitude-Behavior Correspondence Through Exposure to Normative Support From a Salient Ingroup: *Basic and Applied Social Psychology*,.
- White, K.M., Smith, J.R., Terry, D.J., Greenslade, J.H. and McKimmie, B.M., 2009. Social influence in the theory of planned behaviour: the role of descriptive, injunctive, and in-group norms.: *The British journal of social psychology / the British Psychological Society*, **48**, p. 135–158.
- Willy, D.K. and Holm-Müller, K., 2013. Social influence and collective action effects on farm level soil conservation effort in rural Kenya: *Ecological Economics*, **90**, p. 94–103.
- Wilson, G.A., 1997. Factors Influencing Farmer Participation in the Environmentally Sensitive Areas Scheme: *Journal of Environmental Management*, **50**, p. 67–93.
- Wilson, G. a and Hart, K., 2001. Farmer Participation in Agri-Environmental Schemes: Towards Conservation-oriented thinking: *Sociologia Ruralis*, **41**, p. 254–274.
- Wu, J. and Babcock, B.A., 1996. Contract Design for the Purchase of Environmental Goods from Agriculture: *American Journal of Agricultural Economics*, **78**, p. 935–945.
- Wunder, S., 2005. Payments for Environmental Services: Some Nuts and Bolts: *CIFOR Occasional Paper* 42.
- Wunder, S., 2015. Revisiting the concept of payments for environmental services: *Ecological Economics*, **117**, p. 234–243.
- Wunder, S., Engel, S. and Pagiola, S., 2008. Taking stock: A comparative analysis of payments for environmental services programs in developed and developing countries: *Ecological Economics*, **65**, p. 834–852.
- Wynn, G., Crabtree, B. and Potts, J., 2001. Modelling Farmer Entry: **52**, p. 65–82.
- Zabel, A. and Roe, B., 2009. Optimal design of pro-conservation incentives: *Ecological Economics*, **69**, p. 126–134.

# APPENDIX

---



## APPENDIX 1:

### Questionnaire of the TPB survey (Chapter 1)

**Enquête d'opinion sur le dispositif MAET**

Bonjour et bienvenue!

Cette enquête porte sur le dispositif MAET et sur la démarche environnementale de la coopérative des vignerons de Dom Brial. Elle a pour objectif:

- 1) d'identifier les motivations des personnes ayant l'intention d'adopter ou ne pas adopter les MAET proposées dans la zone
- 2) d'évaluer la perception des vignerons sur la démarche environnementale de la coopérative.

In fine, les conclusions de cette étude ont pour objectif d'améliorer les politiques d'appui aux agriculteurs sur les questions agro-environnementales.

Nous vous assurons la confidentialité des informations et votre entier anonymat. Vous pouvez donc répondre en toute tranquillité. Afin d'assurer l'efficacité de l'étude, nous vous invitons à y répondre de manière spontanée, sans revenir sur les réponses précédentes. Ce n'est pas un questionnaire destiné à mesurer vos connaissances. Nous ne vous demandons pas de savoir répondre, mais de répondre de la manière la plus proche de votre opinion personnelle.

La durée estimée de réponse au questionnaire est de 1h environ.

La plupart des questions sont présentées sous forme d'affirmation. Nous vous demanderons si vous êtes d'accord ou non avec ces informations. En général, vous allez devoir répondre sur des échelles à 7 points : vous devrez décider du niveau qui représente le mieux votre opinion.

Il y a 55 questions dans ce questionnaire.

Charger un questionnaire non terminéSuivant >>Sortir et effacer le questionnaire

Ce questionnaire n'est actuellement pas activé. Vous ne pourrez pas sauver vos réponses.

1. Questions préliminaires

Questions préliminaires

\* Etes-vous au courant de la possibilité de signer un contrat MAET pour la réduction d'utilisation d'herbicides ?

Oui  Non

\* Avez vous signé une MAET de réduction des herbicides au cours de l'année 2014?

Oui  Non

\* Quelle est la surface de l'exploitation?

ha

*Seuls des nombres peuvent être entrés dans ce champ*

\* Quelle est la surface en vigne de l'exploitation?

ha

*Seuls des nombres peuvent être entrés dans ce champ*

\* Quelles sont vos pratiques actuelles de gestion des mauvaises herbes?

*Seuls des nombres peuvent être entrés dans ce champ*

**Desherbage chimique en plein**

ha

**Contrôle mécanique des mauvaises herbes dans le rang et désherbage chimique sur le rang**

ha

**Contrôle des mauvaises herbes uniquement mécanique**

ha

\* Quels sont les rendements moyens sur l'exploitation ?

En hectolitres/ha

*Seuls des nombres peuvent être entrés dans ce champ*

2. Attitude vis à vis des MAE

\*  
 Quelle est votre opinion sur les résultats possibles (listés ci-dessous) sur votre exploitation de l'adoption d'une MAET herbicide ?

	Le fait que ce résultat se réalise est :							Pour moi ce résultat est :						
	1 Très improbable	2	3	4	5	6	7 Très probable	1 Pas du tout important	2	3	4	5	6	7 Très important
Résolution de contraintes techniques sur le désherbage chimique	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Acquisition facilité de matériel de désherbage mécanique	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Compensation de la perte de revenu liée au changement de pratique	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bénéfice d'un accompagnement technique pour un changement de pratiques	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Incertitude sur la possibilité de contrôler mécaniquement les mauvaises herbes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Perte de flexibilité technique dans la gestion des mauvaises herbes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Augmentation du temps de travail administratif	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Perte d'autonomie de gestion pendant 5 ans	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Risque accru de contrôles (ZNT, PAC...)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**\* Mon opinion sur les MAET herbicide est:**

*Veillez sélectionner une réponse ci-dessous*

-3 Très défavorable     -2     -1     Neutre     +1     +2     +3 Très favorable

**Un traitement herbicide coûte en moyenne 180€/ha et par traitement pour le produit, combien seriez-vous prêt à payer en plus pour un produit herbicide aussi efficace que celui utilisé aujourd'hui et totalement biodégradable sans impact sur la qualité de l'eau (en %)**

%  
*Seuls des nombres peuvent être entrés dans ce champ*

**\* Le paiement pour la mesure Phyto-2 à 243€/ha est :**

*Veillez sélectionner une réponse ci-dessous*

-3 Très inférieur     -2     -1     Egal     +1     +2     +3 Très supérieur

**?** au coût moyen par ha qu'engendrerait l'adoption d'une MAET herbicide sur mon exploitation.

**\* Le paiement pour la mesure Phyto-10 à 165€/ha est :**

*Veillez sélectionner une réponse ci-dessous*

-3 Très inférieur     -2     -1     Egal     +1     +2     +3 Très supérieur

**?** au coût moyen par ha qu'engendrerait l'adoption d'une MAET herbicide sur mon exploitation.

3. Contrôle sur les décisions

\* Différentes contraintes ont pu/peuvent rendre difficile l'adoption d'une MAET herbicide. Que pensez vous des contraintes listées ci-dessous?

	Cette contrainte se présentera suite à l'adoption d'une MAET.							Cette contrainte rendra/a rendu difficile mon adoption d'une MAET herbicide						
	1 Très improbable	2	3	4	5	6	7 Très probable	-3 Pas du tout d'accord	-2	-1	Neutre	+1	+2	+3 Tout à fait d'accord
Manque de main d'oeuvre	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Manque de formation/information sur les techniques	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Manque d'informations sur les contrats/la réglementation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Capacité financière insuffisante	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Contraintes météorologiques rendant difficile le contrôle mécanique des mauvaises herbes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Difficulté à mécaniser (Type de sol, écartement vigne, pente)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\* Différentes opportunités peuvent faciliter l'adoption d'une MAET, que pensez-vous des opportunités ci-dessous.

	Cette opportunité se présentera suite à l'adoption d'une MAET							Cette opportunité facilitera/a facilité mon adoption d'une MAET						
	1 Très improbable	2	3	4	5	6	7 Très probable	-3 Pas du tout d'accord	-2	-1	Neutre	+1	+2	+3 Tout à fait d'accord
Anticipation de contraintes réglementaires de plus en plus fortes sur le désherbage chimique	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Une dynamique collective autour du changement de pratique	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\* Pour moi, adopter une MAET herbicide est :

*Veillez sélectionner une réponse ci-dessous*

1  
Très facile

2

3

4

5

6

7  
Très difficile

\* Le fait d'adopter une MAET herbicide est une décision personnelle qui ne dépend que de ma volonté.

*Veillez sélectionner une réponse ci-dessous*

-3  
Pas du tout d'accord

-2

-1

Neutre

+1

+2

+3  
Tout à fait d'accord

4. Normes personnelles

\* Merci d'indiquer votre opinion sur les affirmations suivantes portant sur l'environnement en général.

	-3 Pas du tout d'accord	-2	-1	Neutre	+1	+2	+3 Tout à fait d'accord
La crise écologique à laquelle fait face l'humanité a été considérablement exagérée.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Les innovations technologiques pourront permettre de résoudre la plupart des problèmes environnementaux.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Si la tendance actuelle se poursuit, nous allons bientôt subir une catastrophe écologique majeure.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\* Merci d'indiquer votre opinion sur les affirmations suivantes :

	-3 Pas du tout d'accord	-2	-1	Neutre	+1	+2	+3 Tout à fait d'accord
Les herbicides sont dangereux pour ceux qui les manipulent et les utilisent (agriculteurs)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Les herbicides ont des effets négatifs sur l'environnement.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Les herbicides sont dangereux pour les consommateurs d'eau potable.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Les herbicides sont indispensables pour la viticulture.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\* Les activités suivantes contribuent à la détérioration de la qualité de l'eau par les herbicides dans la zone :

	-3 Pas du tout d'accord	-2	-1	Neutre	+1	+2	+3 Tout à fait d'accord
Voirie (route, SNCF)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gestion des espaces verts	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jardiniers amateurs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Arboriculture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Maraiçage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Viticulture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\* Mes pratiques agricoles de gestion des mauvaises herbes ont un impact négatif sur la qualité de l'eau.  
 Veuillez sélectionner une réponse ci-dessous

-3 Pas du tout d'accord   
  -2   
  -1   
  Neutre   
  +1   
  +2   
  +3 Tout à fait d'accord

\* Par rapport aux autres viticulteurs de la cave, mes pratiques de gestion des mauvaises herbes ont un impact sur la détérioration de la qualité de l'eau :

Veuillez sélectionner une réponse ci-dessous

-3 Très inférieur   
  -2   
  -1   
  Egal   
  +1   
  +2   
  +3 Très supérieur   
  Sans opinion

\* Il est de ma responsabilité de modifier mes pratiques de gestion des mauvaises herbes pour améliorer la qualité de l'eau :  
 Veuillez sélectionner une réponse ci-dessous

-3 Pas du tout d'accord   
  -2   
  -1   
  Neutre   
  +1   
  +2   
  +3 Tout à fait d'accord

\* Je ressens une obligation morale de modifier mes pratiques de gestion des mauvaises herbes pour améliorer la qualité de l'eau.  
 Veuillez sélectionner une réponse ci-dessous

-3 Pas du tout d'accord   
  -2   
  -1   
  Neutre   
  +1   
  +2   
  +3 Tout à fait d'accord

5. Risque

\* Avez-vous souscrit une assurance multirisque climatique ?

Oui  Non

6. Habitude

\* Avez vous déjà signé un CTE/MAE/CAD par le passé?

Oui  Non

\* Certaines personnes aiment renouveler sans cesse leurs activités, tandis que d'autres préfèrent se perfectionner dans ce qu'elles savent faire. Quelle est votre position ?  
Veuillez sélectionner une réponse ci-dessous

- J'aime essayer de nouvelles techniques ou productions sur mon exploitation
- Lorsqu'il s'agit d'une technique ou d'une production encore peu répandue, je préfère voir ses résultats dans d'autres exploitations avant de l'essayer.
- Je ne souhaite pas changer mes pratiques
- Sans opinion

7. Normes sociales

\* Les personnes/institutions ci-dessous peuvent avoir une opinion sur votre adoption d'une MAET herbicide . Merci d'indiquer pour chacune des personnes/institution ce que vous pensez de leur opinion sur ce sujet et si vous souhaitez suivre leur avis.

	Cette personne/institution pense que je devrais/devais adopter une MAET herbicide.								Sur ces questions, je souhaite suivre l'avis de cette personne/institution.							
	-3 Pas du tout d'accord	-2	-1	Neutre	+1	+2	+3 Tout à fait d'accord	Sans opinion	-3 Pas du tout d'accord	-2	-1	Neutre	+1	+2	+3 Tout à fait d'accord	Sans opinion
Enfants	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Parents	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Conjoint	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Voisins viticulteurs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Viticulteurs référents	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Technicien de la coopérative Dom Brial	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Direction de la coopérative Dom Brial	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Techniciens distributeurs phyto	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Elus locaux	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Riverains	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\*

\* La plupart des personnes importantes pour moi pense que je devrais/devais adopter une MAET herbicide.  
 Veuillez sélectionner une réponse ci-dessous

-3 Pas du tout d'accord   
  -2   
  -1   
  Neutre   
  +1   
  +2   
  +3 Tout à fait d'accord

\* Selon vous, combien de viticulteurs de la coopérative sont prêts à adopter une MAET herbicide dans les 3 prochaines années?

viticulteurs  
Seuls des nombres peuvent être entrés dans ce champ

\* Le fait que d'autres agriculteurs s'engagent a influencé/influence mon adoption d'une MAET herbicide.

Veuillez sélectionner une réponse ci-dessous

-3 Pas du tout d'accord   
  -2   
  -1   
  Neutre   
  +1   
  +2   
  +3 Tout à fait d'accord

\* En cas d'adoption d'une MAET herbicide, je pense que:

	-3 Pas du tout d'accord	-2	-1	Neutre	+1	+2	+3 Tout à fait d'accord
ma participation individuelle aura un effet sur la qualité de l'eau.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
ma participation individuelle incitera les autres à s'engager.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
ma participation individuelle me procurera de la satisfaction car je ferai un geste positif pour l'environnement.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
je prendrai moins de risque pour ma santé.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

8. Intention d'adoption

\* On a tendance à surestimer nos bonnes intentions ! Ainsi, nous vous demandons de répondre à la question qui suit avec beaucoup d'attention.  
 J'ai l'intention de signer une MAET herbicide au cours des 3 prochaines années.

Veuillez sélectionner une réponse ci-dessous

1 Très improbable   
  2   
  3   
  4   
  5   
  6   
  7 Très probable   
  Contrat déjà signé

9. Action collective

Etes-vous d'accord avec les affirmations suivantes:

\* Je suis informé de la démarche environnementale de la coopérative

*Veillez sélectionner une réponse ci-dessous*

-3 Pas du tout d'accord     -2     -1     Neutre     +1     +2     +3 Tout à fait d'accord

\* Je partage les objectifs de la coopérative en matière d'environnement.

*Veillez sélectionner une réponse ci-dessous*

-3 Pas du tout d'accord     -2     -1     Neutre     +1     +2     +3 Tout à fait d'accord

\* Je suis en accord avec les actions réalisées par la coopérative dans le cadre de sa démarche environnementale.

*Veillez sélectionner une réponse ci-dessous*

-3 Pas du tout d'accord     -2     -1     Neutre     +1     +2     +3 Tout à fait d'accord

\* Je participe aux décisions prises par la coopérative dans le cadre de sa démarche environnementale.

*Veillez sélectionner une réponse ci-dessous*

-3 Pas du tout d'accord     -2     -1     Neutre     +1     +2     +3 Tout à fait d'accord

\* J'ai confiance dans le fait que la plupart des autres membres de la coopérative participe à la démarche environnementale de la coopérative.  
 Veuillez sélectionner une réponse ci-dessous

-3 Pas du tout d'accord   
  -2   
  -1   
  Neutre   
  +1   
  +2   
  +3 Tout à fait d'accord

\* Différents bénéfices sont attendus de la démarche environnementale de la coopérative, quelle importance accordez-vous à ces différents bénéfices?

	1 Pas du tout important	2	3	4	5	6	7 Très important
Image positive/Fait parler positivement de la coopérative	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Accès à des marchés et/ou amélioration des ventes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Amélioration de la qualité de l'eau	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
La démarche collective contribue à modifier les pratiques des individus	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

10. Questions générales

\* Nom:

\* Prénom:

\* Commune :

\* Année de naissance :

Seuls des nombres peuvent être entrés dans ce champ

\* **Quel est votre niveau de formation ?**  
Veuillez sélectionner une réponse ci-dessous

- Primaire (Certificat d'études, BAA, CAPA...)
- Secondaire courte (CAP, BEP, BEPC, BEA, BPA, BEPA...)
- Secondaire longue (Bac, BTA, Bac Pro, BP...)
- Supérieure (BTS, DUT, Ingénieur, BTSA...)

\* **Vous êtes :**  
Veuillez sélectionner une réponse ci-dessous

- Exploitant à titre principal
- Exploitant à titre secondaire
- Salarié
- Autre :

\* **Statut de l'exploitation :**  
Veuillez sélectionner une réponse ci-dessous

- Exploitant individuel
- Société civile (SCEA...)
- GAEC
- Société commerciale ou coopérative(SA, SARL...)
- EARL
- Groupement de fait
- Autre :

\* **Combien de personnes y compris vous travaillent sur l'exploitation (en UTA)?**

UTA  
Seuls des nombres peuvent être entrés dans ce champ

\* Existe-t-il une autre source de revenu sur l'exploitation (hors exploitation agricole) pour votre foyer ?

Oui  Non

\* Est-ce que tout ou partie de votre production présente un signe de qualité?

*Cochez la ou les réponses*

- Aucun signe de qualité  
 AOP  
 IGP  
 Label Développement Durable  
 Agriculture biologique  
 Autre :

\* Vous vinifiez:

*Seuls des nombres peuvent être entrés dans ce champ*

En cave particulière :  En % de la Surface viticole  
A la coopérative Dom Brial :  En % de la Surface viticole  
Autre coopérative :  En % de la Surface viticole

\* Vous êtes :

*Veillez sélectionner une réponse ci-dessous*

Un homme  
 Une femme

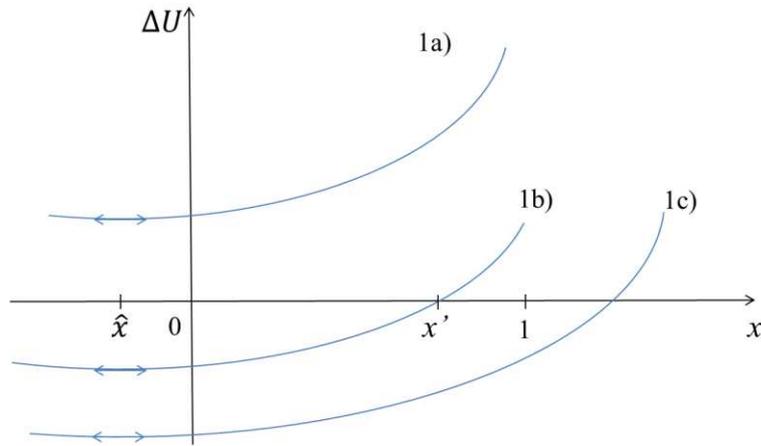


## APPENDIX 2:

### Description of the different possible cases of our model in presence of an injunctive and a descriptive norm (Chapter 2)

**Case 1:**  $\hat{x} \leq 0 \Leftrightarrow \sigma \leq 2\lambda$

The weight of the injunctive norm is not too strong relatively to the weight of the descriptive norm. In this first case  $\Delta U$  is always increasing on  $x \in [0,1]$  and there are 3 subcases:



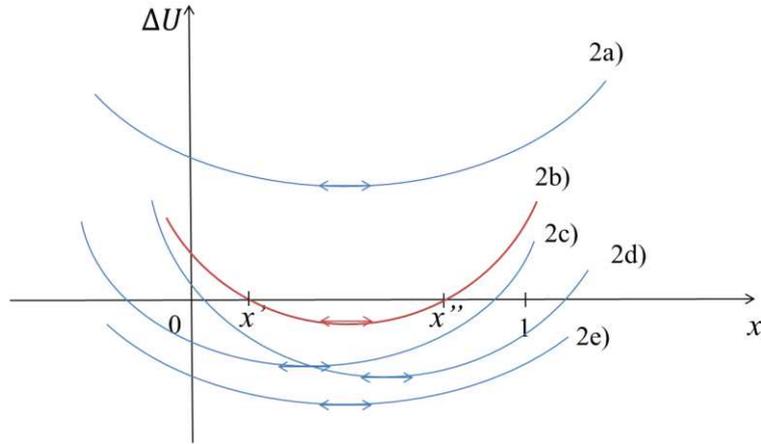
1a) If  $\Delta U > 0$  when  $x = 0$  then  $\Delta U > 0 \forall x \in [0,1]$ . Thus there is a unique Nash equilibrium in which all farmers enrol in AES ( $x = 1$ ).

1b) If  $\Delta U < 0$  when  $x = 0$  and  $\Delta U > 0$  when  $x = 1$  then there is a unique  $x' \in [0,1]$  such that  $\Delta U(x') = 0$ . In that case there are three Nash equilibria:  $x = 0$ ,  $x = 1$  and  $x = x'$ . However there are only two asymptotically stable states  $x = 0$  and  $x = 1$ .

1c) If  $\Delta U < 0$  when  $x = 1$  then  $\Delta U < 0 \forall x \in [0,1]$  thus there is a unique Nash equilibrium in which no farmer enrolls in AES ( $x = 0$ ).

**Case 2:**  $0 < \hat{x} < 1 \Leftrightarrow 2\lambda < \sigma < 8\lambda$

The weight of the injunctive norm is not too strong and not too weak relatively to the weight of the descriptive norm. In this second case,  $\Delta U$  is first decreasing until  $\hat{x}$  and then increasing. There are 5 subcases:



2a) If  $\Delta U_{min} > 0$  then  $\Delta U > 0 \forall x \in [0,1]$  thus there is a unique Nash equilibrium in which all farmers enrol in AES ( $x = 1$ ).

2b) If  $\Delta U_{min} \leq 0$  and  $\Delta U > 0$  when  $x = 0$  and  $\Delta U > 0$  when  $x = 1$  then there are two  $x \in [0,1]$  ( $x'$  and  $x''$ ) such that  $\Delta U(x') = \Delta U(x'') = 0$ . In that case, there are three Nash equilibria:  $x = x'$ ,  $x = x''$  and  $x = 1$ . However there are only two asymptotically stable states in this coordination game:  $x = x'$  and  $x = 1$ .

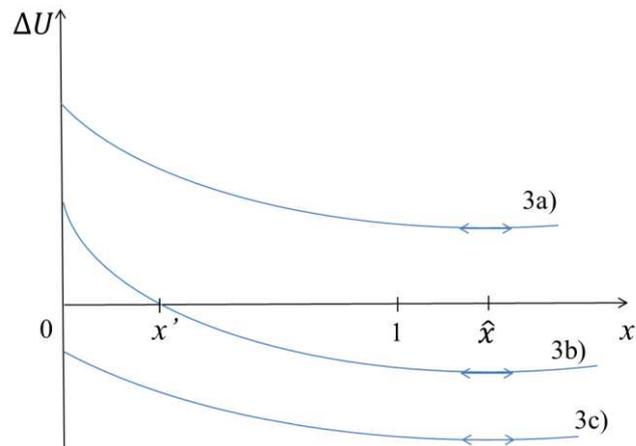
2c) If  $\Delta U_{min} \leq 0$  and  $\Delta U < 0$  when  $x = 0$  and  $\Delta U > 0$  when  $x = 1$  then there is a unique  $x' \in [0,1]$  such that  $\Delta U(x') = 0$ . In that case there are three Nash equilibria:  $x = 0$ ,  $x = 1$  and  $x = x'$ . However there are only two asymptotically stable states  $x = 0$  and  $x = 1$ .

2d) If  $\Delta U_{min} \leq 0$  and  $\Delta U > 0$  when  $x = 0$  and  $\Delta U < 0$  when  $x = 1$  then there is a unique  $x' \in [0,1]$  such that  $\Delta U(x') = 0$ . In that case there is a unique Nash equilibria:  $x = x'$ .

2e) If  $\Delta U_{min} \leq 0$  and  $\Delta U < 0$  when  $x = 0$  and  $\Delta U < 0$  when  $x = 1$  then  $\Delta U < 0 \forall x \in [0,1]$  thus there is a unique Nash equilibrium in which no farmer enrolls in AES ( $x = 0$ ).

**Case 3:**  $\hat{x} \geq 1 \Leftrightarrow \sigma \geq 8\lambda$

The weight of the injunctive norm is sufficiently strong relatively to the weight of the descriptive norm. In this last case  $\Delta U$  is always decreasing and there are 3 subcases:



3a) If  $\Delta U > 0$  when  $x = 1$  then  $\Delta U > 0 \forall x \in [0,1]$  thus there is a unique Nash equilibrium in which all farmers enrol in AES ( $x = 1$ ).

3b) If  $\Delta U > 0$  when  $x = 0$  and  $\Delta U < 0$  when  $x = 1$  then there is a unique  $x' \in [0,1]$  such that  $\Delta U(x') = 0$ . In that case there is a unique Nash equilibria:  $x = x'$ .

3c) If  $\Delta U < 0$  when  $x = 0$  then  $\Delta U < 0 \forall x \in [0,1]$  thus there is a unique Nash equilibrium in which no farmer enrolls in AES ( $x = 0$ ).



## APPENDIX 3:

### Questionnaire of the social norm web survey (Chapter 2)



Institut National de la Recherche Agronomique

#### Bonjour et bienvenue!

Vous êtes bien entré dans le questionnaire portant sur les Mesures Agro-Environnementales (MAE) proposées aux viticulteurs dans le cadre de la nouvelle programmation PAC. Il concerne uniquement les MAE proposées pour l'activité vigne de votre exploitation (Enherbement, désherbage mécanique, réduction des produits phytosanitaires, agriculture biologique...), que nous appellerons « MAE viticoles » dans ce questionnaire. L'objectif est de mieux comprendre les raisons qui peuvent expliquer votre intention de signer ou de ne pas signer une MAE viticole. Cette enquête s'adresse aussi bien aux viticulteurs qui ont l'intention de signer (ou ont déjà signé) une MAE qu'à ceux qui n'ont pas l'intention d'en signer une.

Il vous est demandé de répondre aux questions selon votre situation ou votre opinion. Il vous suffit de cocher une ou plusieurs case(s) selon les questions. La réponse à cette enquête vous prendra moins de 10 minutes.

## I. Renseignements concernant votre exploitation

1. Code postal du siège de l'exploitation :

\_\_\_\_\_

2. Quelle est la Surface Agricole Utile (SAU) de votre exploitation et la surface en vigne ?

SAU = \_\_\_\_\_ ha

Surface vigne = \_\_\_\_\_ ha

3. Quelle est l'activité principale de l'exploitation ? (une seule réponse souhaitée)

Viticulture                       Arboriculture

Grandes cultures             Elevage

Maraîchage

Autres, préciser : \_\_\_\_\_

4. Comment qualifieriez-vous le type de viticulture que vous pratiquez sur votre exploitation ? (une seule réponse souhaitée)

Viticulture conventionnelle

Viticulture raisonnée

Viticulture raisonnée avec cahier des charges

Viticulture biologique (y compris en conversion)

5. En quelle année vous êtes-vous installé(e) sur votre exploitation ? :

\_\_\_\_\_

6. Est-ce que tout ou partie de votre production présente un signe de qualité ? (plusieurs réponses possibles)

AOP    IGP    Label développement durable (Terra Vitis...)    AB    Aucun signe de qualité

7. Comment jugez-vous la rentabilité économique de votre exploitation ?

Pas du tout rentable	Peu rentable	Assez rentable	Très rentable
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

8. Avez-vous effectué d'importants changements dans votre système d'exploitation ces 5 dernières années ? (plusieurs réponses possibles)

Pas de changement notable

Développement d'une nouvelle activité

Agrandissement

En cours de cessation d'activité ou de transmission de l'exploitation

Autre, préciser : \_\_\_\_\_

9. Pensez-vous que quelqu'un reprendra votre exploitation après vous ?  Oui  Non

10. Vous vinifiez principalement

En cave particulière

En cave coopérative

## II. Vos décisions relatives aux MAE viticoles

11. Avez-vous été informé(e) de la possibilité de signer une MAE viticole?

Oui  Non

12. Avez-vous l'intention de signer une MAE viticole en 2015 ?

Je ne suis pas éligible	Pas du tout probable	Peu probable	Assez probable	Très probable
-------------------------	----------------------	--------------	----------------	---------------

éligible

Si « assez probable » ou « très probable » à la question 12

13. Pouvez-vous indiquer quel type de mesure vous avez l'intention de choisir (plusieurs réponses possibles)?

Réduction partielle de l'utilisation des herbicides (Utilisation de herbicides sur seulement une partie de la parcelle et autre méthode sur le reste de la parcelle)

Réduction partielle des autres produits phytosanitaires (Insecticides et fongicides)

Suppression totale des herbicides

Suppression totale des autres produits phytosanitaires

Conversion ou maintien de l'agriculture biologique

14. S'agit-il :

D'un changement de pratiques

Du maintien de pratiques existantes sur mes parcelles ?

15. Sur quelle surface envisagez-vous de signer ce contrat ? \_\_\_\_\_ ha

16. S'agit-il du renouvellement d'un contrat signé au cours de la période précédente ?  Oui  Non

17. Si oui, s'agit-il :

D'un renouvellement à l'identique

De mesures plus exigeantes que dans le précédent contrat

De mesures moins exigeantes que dans le précédent contrat

18. Envisagez-vous de signer une MAE viticole au cours des deux années suivantes (2016, 2017)? (Si « pas du tout probable » ou « peu probable » à question 12)

Pas du tout probable	Peu probable	Assez probable	Très probable
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

19. Avez-vous signé une MAE, un CTE ou un CAD par le passé ?  Oui  Non

### III. Opinions sur les MAE viticoles

20. Mon opinion sur les MAE viticoles est :

Très défavorable	Plutôt défavorable	Neutre	Plutôt favorable	Très favorable
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

21. Signer une MAE viticole sur mon exploitation est :

Très difficile	Assez difficile	Ni difficile ni facile	Assez facile	Très facile
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

22. Les personnes importantes pour moi pensent que je devrais signer une MAE viticole.

Pas du tout d'accord	Plutôt pas d'accord	Neutre	Plutôt d'accord	Tout à fait d'accord
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

23. Je ressens une obligation morale de modifier mes pratiques agricoles pour améliorer la qualité de l'eau.

Pas du tout d'accord	Plutôt pas d'accord	Neutre	Plutôt d'accord	Tout à fait d'accord
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

27. Selon vous, quel pourcentage des viticulteurs de votre territoire :

a signé une MAE lors de la période précédente (avant 2015) ? \_\_\_\_\_%

signera une MAE en 2015 ? \_\_\_\_\_%

signera une MAE au cours des 3 prochaines années (2015, 2016, 2017) ? \_\_\_\_\_%

28. (SI « pas du tout probable » ou « peu probable » à la question 17)  
 Pouvez-vous expliquer en quelques mots les raisons pour lesquelles vous n'envisagez pas de signer une MAE viticole au cours des 3 prochaines années ?

(Sinon)

Pouvez-vous expliquer en quelques mots les raisons pour lesquelles vous envisagez de signer une MAE viticole au cours des 3 prochaines années ?

24. La majorité des viticulteurs du territoire est favorable aux MAE.

Pas du tout d'accord	Plutôt pas d'accord	Neutre	Plutôt d'accord	Tout à fait d'accord
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

25. Comment les autres viticulteurs du territoire perçoivent un viticulteur qui signe une MAE ?

Très mal	Plutôt mal	Ni bien ni mal	Plutôt bien	Très bien
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

26. Je pense que les autres viticulteurs de mon territoire devraient signer une MAE.

Pas du tout d'accord	Plutôt pas d'accord	Neutre	Plutôt d'accord	Tout à fait d'accord
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

#### IV. Renseignements vous concernant

29. Nom : \_\_\_\_\_ Prénom : \_\_\_\_\_

\_\_\_\_\_ Raison sociale : \_\_\_\_\_

*(La réponse à cette question est optionnelle.)*

30. Vous êtes :

Une femme       Un homme

31. Quel âge avez-vous ? \_\_\_\_\_ ans

32. Quel est votre niveau d'étude ?

Primaire (certificat d'études, BAA, CAPA)

Secondaire court (CAP, BEP, BEPC ; BEA, BEPA)

Secondaire long (Bac, BTA, BP)

Supérieur (BTS, DUT, Ingénieur, BTSA)

33. Existe-t-il une autre source de revenus sur l'exploitation (hors exploitation agricole) pour votre foyer ?

OUI     NON

34. Etes-vous exploitant agricole à titre :

Principal

Secondaire

35. Etes-vous membre d'une cave coopérative ?

OUI     NON

36. Etes-vous membre d'un autre groupement d'agriculteurs (CUMA, GDA, CIVAM...) hors syndicat agricole ?

OUI     NON



## APPENDIX 4:

### Instructions of the lab experiment (Chapter 3)

L'expérience à laquelle vous allez participer est destinée à l'étude des décisions. Toutes vos réponses seront traitées de façon anonyme et seront recueillies au travers d'un réseau informatique. Vous indiquerez vos choix à l'ordinateur devant lequel vous êtes assis et celui-ci vous communiquera vos gains réalisés au cours de l'expérience. A partir de maintenant, il vous est demandé de ne plus parler. Si vous avez une question levez la main et un expérimentateur viendra vous répondre en privé.

Durant toute l'expérience vos gains seront exprimés en points. A la fin de l'expérience, le nombre total de points que vous aurez gagnés sera converti en euros selon la règle suivante :

$$1 \text{ point} = 6 \text{ centimes d'euro}$$

Votre gain en euros vous sera versé en liquide, à la fin de l'expérience.

L'expérience comporte 3 séquences. Votre rémunération pour cette expérience sera égale à la somme de votre gain pour la séquence 1 et de votre gain pour l'une des deux autres séquences (2 ou 3). En d'autres termes **une des deux dernières séquences** (soit la séquence 2, soit la séquence 3) **sera tirée au sort pour être rémunérée en plus de la séquence 1.**

A la fin de la séquence 3 un écran **récapitulera l'ensemble des points que vous avez gagnés dans les différentes séquences et indiquera la séquence tirée au sort (entre la séquence 2 et la séquence 3). Cet écran vous informera de votre gain final, en euros, pour l'expérience.**

Avant chaque séquence, vous devrez répondre à une série de questions qui a pour objet de vérifier votre compréhension des instructions. Les réponses données aux questions n'interviennent pas dans le calcul de vos gains.

## SEQUENCE 1

Dans cette séquence, vous devrez prendre des décisions pour 10 jeux différents. Pour chacun de ces jeux vous devrez choisir de participer soit à la loterie A soit à la loterie B. Les règles de la loterie A et de la loterie B sont les suivantes :

- Si vous choisissez la loterie A vous recevrez un gain certain de 20,5 points.
- Si vous choisissez la loterie B vous aurez un pourcentage de chances donné de recevoir 40 points et un pourcentage de chances donné de recevoir 1 point. Ce pourcentage varie dans les différents jeux selon les modalités indiquées dans le tableau ci-dessous.

	<b>Loterie A</b>	<b>Loterie B</b>
<b>Jeu 1</b>	Gain certain de 20,5 points	10% de chances de recevoir 40 points 90% de chances de recevoir 1 point
<b>Jeu 2</b>	Gain certain de 20,5 points	20% de chances de recevoir 40 points 80% de chances de recevoir 1 point
<b>Jeu 3</b>	Gain certain de 20,5 points	30% de chances de recevoir 40 points 70% de chances de recevoir 1 point
<b>Jeu 4</b>	Gain certain de 20,5 points	40% de chances de recevoir 40 points 60% de chances de recevoir 1 point
<b>Jeu 5</b>	Gain certain de 20,5 points	50% de chances de recevoir 40 points 50% de chances de recevoir 1 point
<b>Jeu 6</b>	Gain certain de 20,5 points	60% de chances de recevoir 40 points 40% de chances de recevoir 1 point
<b>Jeu 7</b>	Gain certain de 20,5 points	70% de chances de recevoir 40 points 30% de chances de recevoir 1 point
<b>Jeu 8</b>	Gain certain de 20,5 points	80% de chances de recevoir 40 points 20% de chances de recevoir 1 point
<b>Jeu 9</b>	Gain certain de 20,5 points	90% de chances de recevoir 40 points 10% de chances de recevoir 1 point
<b>Jeu 10</b>	Gain certain de 20,5 points	Gain certain de 40 points

Vous devrez indiquer votre choix pour chacun des 10 jeux. Une fois vos choix effectués, appuyez sur la touche OK.

**Rémunération :**

Pour calculer votre gain pour la séquence, l'ordinateur tire au sort un jeu parmi les 10. Si pour ce jeu vous avez choisi la loterie A, vous recevrez automatiquement 20,5 points. Si vous avez choisi la loterie B, vous aurez les pourcentages de chances spécifiques à ce jeu de gagner 40 points ou 1 point. Les gains réalisés vous seront indiqués à la fin de l'expérience.

## SEQUENCE 2

Pour cette séquence l'ordinateur va former aléatoirement 5 groupes de 4 participants. **Les membres qui composent votre groupe resteront les mêmes à chaque période, jusqu'à la fin de la séquence.** Vous ne pouvez pas identifier les autres membres de votre groupe et ces derniers ne peuvent pas vous identifier. Vos gains vont dépendre de vos décisions ainsi que des décisions des autres membres de votre groupe.

Cette séquence comporte 10 périodes. Au début de chaque période, vous et les 3 autres membres de votre groupe êtes dotés de 20 jetons chacun. A chaque période, vous devez répartir vos jetons entre votre compte individuel et un compte collectif commun à tous les membres de votre groupe (vous y compris). Plus exactement, vous devrez décider du nombre de jetons que vous placez sur le compte collectif. Les jetons restants seront automatiquement placés sur votre compte individuel. Vous êtes libre de placer, sur le compte collectif, n'importe quel nombre entier de jetons compris entre 0 et 20.

### Fonctionnement des comptes

#### Votre compte individuel

Chaque jeton placé dans votre compte individuel vous rapporte 1 point. Ainsi, si vous placez 6 jetons sur votre compte individuel votre gain issu de ce compte est de 6 points. Votre compte individuel ne rapporte des points qu'à vous seul.

#### Le compte collectif

Le compte collectif est commun à tous les membres du groupe. **Si au total le compte collectif comporte 40 jetons ou plus, chaque jeton placé sur ce compte rapporte 0.3 point à chaque membre du groupe.** (Cf. page annexe I : Tableau des gains). Si le nombre total de jetons placés sur le compte collectif par le groupe est inférieur à 40 jetons, le compte collectif ne rapporte aucun point à personne et les jetons placés dans le compte collectif sont perdus.

Exemple 1 :

Vous placez 12 jetons dans le compte collectif et 8 jetons dans votre compte individuel (placés automatiquement). Supposons que les trois autres membres de votre groupe placent au total 38 jetons dans le compte collectif. Le compte collectif comporte donc 50 jetons au total (38 + 12). **Le seuil des 40 jetons est atteint**, ce compte rapporte donc  $0.3 \times 50$  soit 15 points à chaque membre du groupe.

Ainsi, votre gain issu de votre compte individuel est de 8 points et votre gain issu du compte collectif est de 15 points. Votre gain pour la période est donc de 23 points.

Exemple 2 :

Vous placez 8 jetons dans le compte collectif et 12 jetons dans votre compte individuel. Supposons que les trois autres membres de votre groupe placent au total 8 jetons dans le compte collectif. Il y a donc 16 jetons au total (8 + 8) dans le compte collectif. **Le seuil des 40 jetons n'est pas atteint**, le compte collectif rapporte 0 point à chaque membre du groupe.

Ainsi, votre gain issu de votre compte individuel est de 12 points et votre gain issu du compte collectif est de 0 point. Votre gain total pour la période est donc de 12 points.

### **Estimation du nombre total de jetons placés sur le compte collectif par les 3 autres membres de votre groupe**

Vous devrez à chaque période estimer le nombre total de jetons placés dans le compte collectif par les 3 autres membres de votre groupe. Votre gain lié à cette estimation dépend de la différence entre votre estimation et le nombre effectif de jetons placés par les autres membres de votre groupe. Plus vous serez proche du nombre effectif plus votre gain sera élevé. Le tableau ci-dessous vous donne votre gain en fonction de la différence entre l'estimation et le nombre effectif.

Différence entre le nombre estimé et le nombre effectif de jetons placés par les 3 autres membres	Gain lié à l'estimation
0 (estimation exacte)	5 points
Plus ou moins 1 jeton	4 points
Plus ou moins 2 jetons	3 points
Supérieur à 2 jetons (en plus ou en moins)	0 point

Exemple 1 : Vous avez estimé que les autres membres de votre groupe placeraient 31 jetons sur le compte collectif. A la fin de la période, il s'avère qu'ils ont placé 31 jetons dans le compte collectif. Vous gagnez donc 5 points.

Exemple 2 : Vous avez estimé que les autres membres de votre groupe placeraient 31 jetons sur le compte collectif. A la fin de la période, il s'avère qu'ils ont placé 33 jetons. L'écart entre votre estimation et le nombre effectif est de 2 jetons. Vous gagnez donc 3 points (Cf. tableau).

### Déroulement d'une période

Chaque période, vous devrez tout d'abord saisir le nombre de jetons que vous pensez que les 3 autres membres de votre groupe placeront au total dans le compte collectif. Ce nombre doit être un entier compris entre 0 (si chacun des 3 autres membres du groupe place 0 jeton dans le compte collectif) et 60 jetons (si chacun des 3 autres membres de votre groupe place l'ensemble de ses 20 jetons de dotation dans le compte collectif).

Lorsque vous aurez validé, vous aurez un second écran sur lequel vous devrez saisir le nombre de jetons que vous placez dans le compte collectif, un entier compris entre 0 et 20. Les jetons non placés dans le compte collectif seront automatiquement placés par l'ordinateur sur votre compte individuel. En effet, chaque période la totalité de vos 20 jetons est placée. Vous n'avez pas la possibilité de reporter une partie ou la totalité de vos jetons d'une période à l'autre.

**Lorsque tous les participants auront pris leur décision**, le récapitulatif de la période s'affichera. Ce récapitulatif vous rappelle votre décision de placement, vous informe du nombre total de jetons placés par votre groupe dans le compte collectif et de vos gains pour la période.

**Tableau des gains du compte collectif**

<b>Nombre de jetons placés dans le compte collectif par le groupe</b>	<b>Gain issu du compte collectif, pour chaque membre du groupe</b>	<b>Nombre de jetons placés dans le compte collectif par le groupe</b>	<b>Gain issu du compte collectif, pour chaque membre du groupe</b>
<40	0	60	18
40	12	61	18,3
41	12,3	62	18,6
42	12,6	63	18,9
43	12,9	64	19,2
44	13,2	65	19,5
45	13,5	66	19,8
46	13,8	67	20,1
47	14,1	68	20,4
48	14,4	69	20,7
49	14,7	70	21
50	15	71	21,3
51	15,3	72	21,6
52	15,6	73	21,9
53	15,9	74	22,2
54	16,2	75	22,5
55	16,5	76	22,8
56	16,8	77	23,1
57	17,1	78	23,4
58	17,4	79	23,7
59	17,7	80	24
60	18		

### Séquence 3

La composition des groupes est identique à celle de la séquence précédente et restera inchangée jusqu'à la fin de l'expérience. Comme dans la séquence 2, au début de chacune des 10 périodes chaque joueur dispose d'une dotation de 20 jetons qu'il doit répartir entre son compte individuel et le compte collectif commun à tous les membres de son groupe. Le fonctionnement du compte individuel et du compte collectif sont identiques à celui de la séquence précédente ainsi que la procédure d'estimation du nombre de jetons placés sur le compte collectif par les autres membres de votre groupe. L'annexe 1 peut donc toujours être utilisée pour calculer les gains issus du compte collectif.

**La différence avec la séquence 2 réside dans l'existence d'un mécanisme de subvention portant sur le nombre de jetons placés individuellement dans le compte collectif. Si au total le compte collectif comporte 40 jetons ou plus, le montant de la subvention que vous touchez est de 0.3 point par jeton que vous avez placé dans le compte collectif.** Le tableau de l'annexe 2 vous donne le montant de la subvention en fonction du nombre de jetons placés dans le compte collectif.

#### Exemple 1 :

Vous placez 12 jetons dans le compte collectif et 8 jetons dans votre compte individuel. Supposons que les trois autres membres de votre groupe placent au total 38 jetons dans le compte collectif. Le compte collectif comporte donc 50 jetons au total (38 + 12). Le seuil des 40 jetons est atteint, ce compte rapporte  $0.3 \times 50$  soit 15 points à chaque membre du groupe.

Ainsi, votre gain issu de votre compte individuel est de 8 points et votre gain issu du compte collectif est de 15 points. De plus, comme le seuil de 40 jetons sur le compte collectif est atteint, vous recevez une subvention égale à 0.3 point par jeton que vous avez placé dans le compte collectif, soit  $0.3 \times 12 = 3.6$  points. Votre gain total pour la période est donc de 26.6 points.

#### Exemple 2 :

Vous placez 8 jetons dans le compte collectif et 12 jetons dans votre compte individuel. Supposons que les trois autres membres de votre groupe placent au total 8 jetons dans le compte collectif. Le compte collectif compte donc 16 jetons au total (8 + 8). Le seuil des 40 jetons n'est pas atteint, le compte collectif rapportera 0 point à chaque membre du groupe.

Ainsi, votre gain issu de votre compte individuel est de 12 points et votre gain issu du compte collectif est de 0 point. La subvention vous rapporte également 0 point dans la mesure où le seuil de 40 jetons dans le compte collectif n'est pas atteint. Votre gain total pour la période est donc de 12 points.

### **Déroulement d'une période**

Le déroulement est identique à celui de la séquence 2. Le montant de la subvention obtenue sera indiqué dans le récapitulatif de la période.

**Tableau des gains liés à la subvention (dans le cas où le nombre de jetons placés sur le compte collectif par votre groupe est supérieur à 40)**

<b>Nombre de jetons que vous avez placés dans le compte collectif</b>	<b>Montant de la subvention</b>
0	0
1	0,3
2	0,6
3	0,9
4	1,2
5	1,5
6	1,8
7	2,1
8	2,4
9	2,7
10	3
11	3,3
12	3,6
13	3,9
14	4,2
15	4,5
16	4,8
17	5,1
18	5,4
19	5,7
20	6

## APPENDIX 5:

### Main determinants of adoption of AES in the literature (Chapter 4)

Determinants	Effect	Reference
<b><u>Farmer and farm socio-economic factors</u></b>		
Area	+	Allaire <i>et al.</i> , 2009; Falconer, 2000; Morris and Potter, 1995; Wilson, 1997
Age	-	Bonnieux <i>et al.</i> , 1998; Chabé-Ferret and Subervie, 2013; Ducos <i>et al.</i> , 2009; Morris and Potter, 1995; Ruto and Garrod, 2009; Vanslebrouck <i>et al.</i> , 2002; Wynn <i>et al.</i> , 2001
	+ (for measures with extensification)	(Drake <i>et al.</i> , 1999)
Education	+	Allaire <i>et al.</i> , 2009; Chabé-Ferret and Subervie, 2013; Louis and Rousset, 2010; Wilson, 1997
<b><u>Contract characteristics</u></b>		
Short duration	+	Bougherara and Ducos, 2006; Christensen <i>et al.</i> , 2011; Louis and Rousset, 2010; Ruto and Garrod, 2009
Flexibility on plot selection by farmers	+	Bougherara and Ducos, 2006; Ruto and Garrod, 2009
Flexibility on technical prescriptions	+	Bougherara and Ducos, 2006; Christensen <i>et al.</i> , 2011; Kuhfuss <i>et al.</i> , 2014; Ruto and Garrod, 2009
<b><u>Payment level and costs</u></b>		
Payment superior to costs	+	Brotherton, 1991; Drake <i>et al.</i> , 1999
Low compliance and opportunity costs	+	Delvaux <i>et al.</i> , 1999; Louis and Rousset, 2010; Vanslebrouck <i>et al.</i> , 2002; Wynn <i>et al.</i> , 2001.
Transaction costs	-	Ducos and Dupraz, 2007; Falconer, 2000; Peerlings and Polman, 2009; Vatn, 2010
Asset specificity	-	Ducos and dupraz, 2007; Rorstad <i>et al.</i> , 2007
Previous participation in similar schemes	+	Allaire <i>et al.</i> , 2009; Chabé-Ferret and Subervie, 2013; Louis and Rousset, 2010; Kuhfuss <i>et al.</i> , 2013
<b><u>Behavioral factors</u></b>		
Attitude towards the environment	+	Beedell and Rehman, 2000; Defrancesco <i>et al.</i> , 2007; Delvaux <i>et</i>

<b>Determinants</b>	<b>Effect</b>	<b>Reference</b>
		al., 1999; Ducos et al., 2009; Morris and Potter, 1995; Mzoughi, 2011
Participation in environmental association and nature hobbies	+	Beedell and Rehman, 2000.
Social norms	+	Fielding et al., 2005; Beedell and Rehman, 1999
Trust between contracting partners	+	Ducos and Dupraz, 2007; Ducos et al., 2009; Louis and Rousset, 2010; Peerlings and Polman, 2009
Risk aversion	+ (because AES bring a secured revenue)	Fraser, 2004, Karsenty, 2010
	- (uncertainty regarding the future of AES)	Slangen, 1997, Sumpsi et al, 1998
Trust in the results of the programme	+	Gibbons et al., 2007, Karsenty et al., 2010

## APPENDIX 6:

### Questionnaire of the ABOS survey (Chapter 4).

#### **Enquête sur les mesures MAERFF (mesures outardes) proposées aux agriculteurs suite au projet de contournement ferroviaire de Nîmes-Montpellier**

Dans ce questionnaire, il vous est demandé de répondre aux questions selon votre situation ou votre opinion. Pour répondre aux questions, il vous suffit de cocher une ou plusieurs case(s) selon les questions. Nous vous prions de bien vouloir répondre à TOUTES les questions qui vous concernent. L'absence de réponse à certaines questions pose en effet des problèmes dans le traitement des données. Merci d'avance de votre contribution !

#### **I. Renseignements concernant votre exploitation**

<p>37. Quelle est la Surface Agricole Utile (SAU) de votre exploitation (incluant les parcelles non exploitées) ?</p> <p>SAU = _____ ha dont _____ ha de luzerne</p>	<p>38. Quel est le statut de votre exploitation ?</p> <p><input type="checkbox"/> Exploitant individuel</p> <p><input type="checkbox"/> GAEC</p> <p><input type="checkbox"/> Autres formes sociétaires</p>								
<p>39. Quelle est l'activité principale de l'exploitation ? (une seule réponse souhaitée)</p> <p><input type="checkbox"/> Grandes cultures    <input type="checkbox"/> Arboriculture</p> <p><input type="checkbox"/> Viticulture            <input type="checkbox"/> Elevage</p> <p><input type="checkbox"/> Maraîchage            <input type="checkbox"/> Production fourragère</p> <p><input type="checkbox"/> Autres, préciser : _____</p>	<p>40. Comment qualifieriez-vous le type d'agriculture que vous pratiquez sur votre exploitation ? (une seule réponse souhaitée)</p> <p><input type="checkbox"/> Agriculture conventionnelle</p> <p><input type="checkbox"/> Agriculture raisonnée</p> <p><input type="checkbox"/> Agriculture biologique</p>								
<p>41. En quelle année vous êtes-vous installé(e) sur votre exploitation ? : _____</p>	<p>42. Quel est le nombre de personnes qui travaillent sur l'exploitation (vous compris) ? _____</p>								
<p>43. Comment jugez-vous la rentabilité économique de votre exploitation ?</p> <table border="1" style="width: 100%; text-align: center; border-collapse: collapse;"> <tr> <td style="padding: 5px;">Pas du tout rentable</td> <td style="padding: 5px;">Peu rentable</td> <td style="padding: 5px;">Assez rentable</td> <td style="padding: 5px;">Très rentable</td> </tr> <tr> <td style="padding: 5px;"><input type="checkbox"/></td> <td style="padding: 5px;"><input type="checkbox"/></td> <td style="padding: 5px;"><input type="checkbox"/></td> <td style="padding: 5px;"><input type="checkbox"/></td> </tr> </table>	Pas du tout rentable	Peu rentable	Assez rentable	Très rentable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<p>44. Avez-vous effectué d'importants changements dans votre système d'exploitation ces 5 dernières années ? (plusieurs réponses possibles)</p> <p><input type="checkbox"/> Pas de changement notable</p> <p><input type="checkbox"/> Développement d'une nouvelle activité</p> <p><input type="checkbox"/> Agrandissement</p> <p><input type="checkbox"/> En cours de cessation d'activité ou de transmission de l'exploitation</p> <p><input type="checkbox"/> Autre, préciser : _____</p>
Pas du tout rentable	Peu rentable	Assez rentable	Très rentable						
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>						

## II. Renseignements vous concernant

45. Vous êtes : <input type="checkbox"/> Une femme <input type="checkbox"/> Un homme	46. Quel âge avez-vous ? _____
47. Quel est votre niveau d'étude ? <input type="checkbox"/> Primaire (certificat d'études, BAA, CAPA) <input type="checkbox"/> Secondaire court (CAP, BEP, BEPC ; BEA, BEPA) <input type="checkbox"/> Secondaire long (Bac, BTA, BP) <input type="checkbox"/> Supérieur (BTS, DUT, Ingénieur, BTSA)	48. Etes-vous exploitant agricole à titre : <input type="checkbox"/> Principal <input type="checkbox"/> Secondaire
49. Etes-vous membre d'une organisation agricole type syndicat des éleveurs ou cave coopérative (hors syndicat FNSEA ou confédération paysanne) ?  <input type="checkbox"/> OUI <input type="checkbox"/> NON	50. Faites-vous ou avez-vous fait partie d'une association environnementale ou participez-vous à des activités de nature (type randonnée, chasse, pêche, etc.) ?  <input type="checkbox"/> OUI <input type="checkbox"/> NON
51. Code postal du siège de l'exploitation :  _____	52. Pensez-vous que quelqu'un reprendra votre exploitation après vous ?  <input type="checkbox"/> OUI <input type="checkbox"/> NON

## III. Renseignements concernant les contrats MAERFF

53. Avez-vous été informé(e) de la possibilité de signer un contrat MAERFF ? <input type="checkbox"/> OUI <input type="checkbox"/> NON  Si OUI, par qui ? (plusieurs réponses possibles) <input type="checkbox"/> Chambre d'agriculture <input type="checkbox"/> Autre(s) agriculteur(s) <input type="checkbox"/> Coopérative ou organisation agricole <input type="checkbox"/> Autre, préciser : _____	54. Avez-vous signé un contrat MAERFF ? <input type="checkbox"/> OUI <input type="checkbox"/> NON  Si OUI, en quelle année ? : _____  55. Avez-vous l'intention de signer un nouveau contrat MAERFF ou MAEOC dans les prochaines années ? <table border="1"> <tr> <td>Pas du tout probable</td> <td>Peu probable</td> <td>Assez probable</td> <td>Très probable</td> </tr> <tr> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> </table>	Pas du tout probable	Peu probable	Assez probable	Très probable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Pas du tout probable	Peu probable	Assez probable	Très probable								
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>								
56. Comment évaluez-vous les montants proposés dans les contrats MAERFF par rapport aux coûts des actions prévues dans les cahiers des charges ? <table border="1"> <tr> <td>Très inférieurs</td> <td>Plutôt inférieurs</td> <td>Egaux</td> <td>Plutôt supérieurs</td> <td>Très supérieurs</td> </tr> <tr> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> </table>	Très inférieurs	Plutôt inférieurs	Egaux	Plutôt supérieurs	Très supérieurs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	57. Avez-vous vendu des terres agricoles dans le cadre de la construction de la ligne LGV (incluant les expropriations) ? <input type="checkbox"/> OUI <input type="checkbox"/> NON
Très inférieurs	Plutôt inférieurs	Egaux	Plutôt supérieurs	Très supérieurs							
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>							

58. Pouvez-vous indiquer si vous êtes en **accord** ou en **désaccord** avec les affirmations suivantes : (une seule réponse souhaitée par affirmation)

Affirmations	Niveau d'accord				
	Pas du tout d'accord	Plutôt pas d'accord	Plutôt d'accord	Tout à fait d'accord	Je ne sais pas
La diversité des mesures proposées dans les contrats MAERFF est un avantage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Les rémunérations proposées dans les contrats MAERFF sont intéressantes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Les règles et les exigences des contrats MAERFF sont faciles à comprendre	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Les mesures proposées dans les contrats MAERFF sont faciles à mettre en œuvre sur mon exploitation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Il y a beaucoup de contrôles de la mise en œuvre des mesures des contrats MAERFF	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Les sanctions en cas de non respect des règles et des engagements des contrats MAERFF sont raisonnables	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Il est facile de trouver de l'aide auprès des personnes en charge des contrats MAERFF en cas de problème	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Il est possible de renégocier les engagements des contrats MAERFF en cas de difficultés rencontrées ou d'évolution de la situation de l'exploitation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Il est facile de se désengager des contrats MAERFF	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Le fait que d'autres agriculteurs s'engagent également dans les contrats MAERFF est important pour moi	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

59. Pouvez-vous indiquer si vous êtes en **accord** ou en **désaccord** avec les affirmations suivantes : (1 réponse/affirmation)

Affirmations	Niveau d'accord				
	Pas du tout	Plutôt pas d'accord	Plutôt d'accord	Tout à fait d'accord	Je ne sais pas
L'engagement dans les MAERFF nécessite pour vous d'investir dans du matériel spécifique ou d'en louer (machine ou matériel agricole, clôtures, etc.)	Pas du tout <input type="checkbox"/>	Plutôt pas d'accord <input type="checkbox"/>	Plutôt d'accord <input type="checkbox"/>	Tout à fait d'accord <input type="checkbox"/>	Je ne sais pas <input type="checkbox"/>
L'engagement dans les MAERFF nécessite beaucoup de temps pour les démarches administratives (dossier à remplir, signature contrat, etc.)	Pas du tout <input type="checkbox"/>	Plutôt pas d'accord <input type="checkbox"/>	Plutôt d'accord <input type="checkbox"/>	Tout à fait d'accord <input type="checkbox"/>	Je ne sais pas <input type="checkbox"/>
L'engagement dans les MAERFF nécessite de se former (suivre des formations, participer à des réunions)	Pas du tout <input type="checkbox"/>	Plutôt pas d'accord <input type="checkbox"/>	Plutôt d'accord <input type="checkbox"/>	Tout à fait d'accord <input type="checkbox"/>	Je ne sais pas <input type="checkbox"/>
La mise en œuvre des mesures des contrats MAERFF nécessite d'avoir recours à des personnes extérieures à l'exploitation (autres agriculteurs, prestataires de service)	Pas du tout <input type="checkbox"/>	Plutôt pas d'accord <input type="checkbox"/>	Plutôt d'accord <input type="checkbox"/>	Tout à fait d'accord <input type="checkbox"/>	Je ne sais pas <input type="checkbox"/>
Les mesures proposées dans les MAERFF s'intègrent bien dans mon système d'exploitation	Pas du tout <input type="checkbox"/>	Plutôt pas d'accord <input type="checkbox"/>	Plutôt d'accord <input type="checkbox"/>	Tout à fait d'accord <input type="checkbox"/>	Je ne sais pas <input type="checkbox"/>
Les mesures MAERFF représentent une opportunité de valoriser des parcelles non exploitées	Pas du tout <input type="checkbox"/>	Plutôt pas d'accord <input type="checkbox"/>	Plutôt d'accord <input type="checkbox"/>	Tout à fait d'accord <input type="checkbox"/>	Je ne sais pas <input type="checkbox"/>
Les mesures MAERFF représentent une opportunité de mettre en œuvre des actions que je faisais déjà ou que j'allais faire prochainement sur l'exploitation	Pas du tout <input type="checkbox"/>	Plutôt pas d'accord <input type="checkbox"/>	Plutôt d'accord <input type="checkbox"/>	Tout à fait d'accord <input type="checkbox"/>	Je ne sais pas <input type="checkbox"/>
Il est important que la chambre d'agriculture participe à l'animation des MAERFF	Pas du tout <input type="checkbox"/>	Plutôt pas d'accord <input type="checkbox"/>	Plutôt d'accord <input type="checkbox"/>	Tout à fait d'accord <input type="checkbox"/>	Je ne sais pas <input type="checkbox"/>
Les actions mises en œuvre dans le dispositif des MAERFF permettront de protéger les oiseaux menacés	Pas du tout <input type="checkbox"/>	Plutôt pas d'accord <input type="checkbox"/>	Plutôt d'accord <input type="checkbox"/>	Tout à fait d'accord <input type="checkbox"/>	Je ne sais pas <input type="checkbox"/>
La protection des populations d'oiseaux menacés est importante pour notre territoire	Pas du tout <input type="checkbox"/>	Plutôt pas d'accord <input type="checkbox"/>	Plutôt d'accord <input type="checkbox"/>	Tout à fait d'accord <input type="checkbox"/>	Je ne sais pas <input type="checkbox"/>
Le statut foncier de mes parcelles est un obstacle à mon adhésion aux contrats MAERFF	Pas du tout <input type="checkbox"/>	Plutôt pas d'accord <input type="checkbox"/>	Plutôt d'accord <input type="checkbox"/>	Tout à fait d'accord <input type="checkbox"/>	Je ne sais pas <input type="checkbox"/>

60. Pensez-vous que les institutions qui financent les contrats MAERFF (RFF et Oc'Via) honoreront leurs engagements ?

Pas du tout d'accord	Plutôt pas d'accord	Plutôt d'accord	Tout à fait d'accord	Je ne sais pas
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

61. Etes-vous en accord ou en désaccord avec les affirmations suivantes :

« J'ai confiance dans les institutions en charge du suivi et de la mise en œuvre des contrats MAERFF (le Conservatoire des Espaces Naturels (CEN), le Centre Ornithologique du Gard (COGARD) et la Chambre d'agriculture du Gard) »

Pas du tout d'accord	Plutôt pas d'accord	Plutôt d'accord	Tout à fait d'accord	Je ne sais pas
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

« J'ai confiance dans la gestion des politiques agro-environnementales par les pouvoirs publics (Services de l'Etat, Europe) »

Pas du tout d'accord	Plutôt pas d'accord	Plutôt d'accord	Tout à fait d'accord	Je ne sais pas
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

62. Pensez-vous qu'il est de votre responsabilité en tant qu'agriculteur d'agir pour la protection des oiseaux menacés ?

Pas du tout d'accord	Plutôt pas d'accord	Plutôt d'accord	Tout à fait d'accord	Je ne sais pas
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

63. Selon vous, quel est le principal acteur qui devrait se mobiliser pour agir en faveur des oiseaux menacés ? (une seule réponse souhaitée)

- |  |   |
|--|---|
| <input type="checkbox"/> Les acteurs publics (Etat, collectivités territoriales, etc.) | <input type="checkbox"/> Les agriculteurs         |
| <input type="checkbox"/> Les acteurs privés (entreprises, aménageurs, etc.)            | <input type="checkbox"/> Les citoyens             |
| <input type="checkbox"/> Les associations environnementales                            | <input type="checkbox"/> Autres, préciser : _____ |

#### IV. Opinions sur les MAERFF

64. Quelle est votre opinion sur la <u>compensation par des actions agricoles</u> de dommages environnementaux occasionnés par la construction d'infrastructure ?	Opinion très négative <input type="checkbox"/>	Plutôt négative <input type="checkbox"/>	Plutôt positive <input type="checkbox"/>	Très positive <input type="checkbox"/>	Je ne sais pas <input type="checkbox"/>
---	---	---	---	---	--

65. Pouvez-vous indiquer l'opinion des personnes ou organisations suivantes sur les contrats MAERFF et l'influence de cette opinion sur votre décision de signer un contrat MAERFF :

Personnes / Organisations	Quelle est l' <b>OPINION</b> des personnes ou organisations suivantes <u>sur les contrats MAERFF</u> ?	Est-ce que cette opinion a eu une <b>INFLUENCE</b> sur votre <u>décision de signer</u> un contrat MAERFF ?
Chambre agriculture	<input type="checkbox"/> Positive pas <input type="checkbox"/> Négative <input type="checkbox"/> Sans opinion / Je ne sais pas	<input type="checkbox"/> OUI <input type="checkbox"/> NON <input type="checkbox"/> Je ne sais pas
Coopératives agricoles	<input type="checkbox"/> Positive pas <input type="checkbox"/> Négative <input type="checkbox"/> Sans opinion / Je ne sais pas	<input type="checkbox"/> OUI <input type="checkbox"/> NON <input type="checkbox"/> Je ne sais pas
Services de l'Etat locaux (DREAL, DDTM)	<input type="checkbox"/> Positive pas <input type="checkbox"/> Négative <input type="checkbox"/> Sans opinion / Je ne sais pas	<input type="checkbox"/> OUI <input type="checkbox"/> NON <input type="checkbox"/> Je ne sais pas
Associations environnementales	<input type="checkbox"/> Positive pas <input type="checkbox"/> Négative <input type="checkbox"/> Sans opinion / Je ne sais pas	<input type="checkbox"/> OUI <input type="checkbox"/> NON <input type="checkbox"/> Je ne sais pas
Elus locaux	<input type="checkbox"/> Positive pas <input type="checkbox"/> Négative <input type="checkbox"/> Sans opinion / Je ne sais pas	<input type="checkbox"/> OUI <input type="checkbox"/> NON <input type="checkbox"/> Je ne sais pas
Autres agriculteurs	<input type="checkbox"/> Positive pas <input type="checkbox"/> Négative <input type="checkbox"/> Sans opinion / Je ne sais pas	<input type="checkbox"/> OUI <input type="checkbox"/> NON <input type="checkbox"/> Je ne sais pas

## V. Participation à d'autres programmes agro-environnementaux

66. Avez-vous déjà contractualisé un CTE ou CAD par le passé?

OUI  NON

67. Avez-vous été informé(e) de la possibilité de signer une MAEt Natura 2000 dans le cadre de votre dossier PAC ?

OUI  NON

68. Etes-vous actuellement en contrat MAEt Natura 2000?

OUI  NON

69. Si NON, pourquoi avez-vous choisi de contractualiser une MAERFF plutôt qu'une MAEt Natura 2000 ? (plusieurs réponses possibles)

- Plus grande flexibilité des contrats (durée, contrôles, sanctions...)
- La chambre d'agriculture m'a conseillé de plutôt signer une MAERFF
- Je ne suis pas éligible pour la signature d'une MAEt Natura 2000
- Je n'ai pas constitué de dossier PAC et la signature d'une MAEt Natura 2000 aurait été trop compliquée
- Les mesures proposées dans le cadre des MAEt Natura 2000 ne convenaient pas à mon exploitation
- Je n'ai pas confiance dans les institutions qui financent et gèrent les contrats MAEt (Union européenne, Services de l'Etat)
- Autres. Préciser : \_\_\_\_\_

## VI. Renseignements sur votre/vos contrat(s) MAERFF

70. Quelle est la surface totale que vous avez engagée dans les contrats MAERFF ? \_\_\_\_\_ ha

71. Merci de cocher les mesures pour lesquelles vous vous êtes engagé(e) dans les contrats MAERFF : (plusieurs réponses possibles)

- 1- Création et entretien d'un couvert favorable à l'Outarde
- 2- Amélioration par sur-semis d'un couvert herbacé et entretien
- 3- Entretien d'un couvert herbacé avec retard de pâturage
- 4- Entretien d'un couvert herbacé avec retard de fauche
- 5- Réouverture d'une parcelle embroussaillée et girobroyage annuel
- 6- Gestion mécanique de friches herbacées
- 8- Implantation d'enherbement inter-rang en vigne

9- Maintien et entretien de l'enherbement inter-rang en vigne

10- Maintien des chaumes après récolte

11- Implantation d'une culture intermédiaire annuelle (comme la colza)

12- Suppression de haie

72. Comment qualifieriez-vous l'importance du changement de vos pratiques suite à votre engagement dans les contrats MAERFF ? (une seule réponse souhaitée)

Aucune modification

Faible

Moyenne

Forte

73. Pouvez-vous décrire succinctement les changements principaux de pratique ou de système d'exploitation que vous avez opérés suite à la signature des contrats MAERFF (en plus de ceux prévus dans le cahier des charges des MAERFF) ?

---

---

74. Quelle surface était cultivée en luzerne sur votre exploitation avant de signer la MAERFF : \_\_\_\_\_ ha

75. A quelle fréquence échangez-vous avec les personnes en charge du programme de contractualisation MAERFF ? (une seule réponse souhaitée)

Plusieurs fois par mois  Quelques fois par an  Moins d'une fois par an

Plutôt une fois par mois  Une fois par an

76. Etes-vous en accord ou en désaccord avec l'affirmation suivante :

« Je suis convaincu(e) que les actions que je mets en œuvre dans le cadre de mes engagements MAERFF sont favorables à la protection des oiseaux menacés »

Pas du tout d'accord	Plutôt pas d'accord	Plutôt d'accord	Tout à fait d'accord	Je ne sais pas
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

77. Sur quels critères avez-vous sélectionné les parcelles que vous avez proposées pour les contrats MAERFF ?

(Cocher les 2 principaux critères de la liste suivante)

Critères de sélection	Choix des 2 critères principaux
Des parcelles qui me semblaient intéressantes d'un point de vue écologique	<input type="checkbox"/>
Des parcelles sur lesquelles il était facile pour moi de mettre en œuvre les pratiques	<input type="checkbox"/>
Des parcelles sur lesquelles je réalisais déjà les pratiques demandées dans le cahier charges	<input type="checkbox"/>
Des parcelles peu productives	<input type="checkbox"/>
Des parcelles éloignées de mon exploitation	<input type="checkbox"/>

78. Si vous avez rencontré des difficultés pendant la durée de votre engagement, pouvez-vous préciser à quel niveau se trouvaient-elles ? (plusieurs réponses possibles)

- Pas de difficultés particulières
- Difficultés techniques et/ou agronomiques pour le respect du cahier des charges des MAERFF
- Difficultés dans l'organisation de l'activité agricole
- Manque de temps pour réaliser les actions
- Rentabilité insuffisante des parcelles engagées dans les MAERFF
- Valorisation difficile des cultures introduites (luzerne, colza)
- Autres.

Préciser : \_\_\_\_\_

79. Suite à ces difficultés avez-vous renégocié certains éléments du contrat ?  OUI

NON

80. Si OUI, sur quels éléments ont porté ces renégociations? (plusieurs réponses possibles)

- Adaptation des actions de la mesure (par exemple modification des dates d'intervention)
- Changement de mesures
- Diminution des surfaces engagées
- Abandon du contrat
- Suspension temporaire du contrat
- Autres. Préciser : \_\_\_\_\_

81. Que pensez-vous faire à la fin de votre contrat MAERFF ? (une seule réponse souhaitée)

- Signer un nouveau contrat pour les mêmes superficies
- Signer un nouveau contrat pour une superficie plus importante
- Signer un nouveau contrat pour une superficie moins importante
- Ne pas signer de nouveau contrat

82. Que pensez-vous faire en ce qui concerne vos pratiques, si à l'avenir vous n'êtes plus en contrat MAERFF ? (une seule réponse souhaitée)

- Maintenir les pratiques prévues dans le contrat MAERFF
  - Adopter d'autres pratiques favorables à la protection des oiseaux menacés
  - Ne pas maintenir les pratiques prévues dans le contrat MAERFF
  - Autres : préciser
- 

83. Pouvez-vous décrire succinctement les bénéfices que vous avez retirés de votre engagement dans les MAERFF ?

---

84. Merci de nous indiquer vos éventuelles remarques ou propositions d'amélioration du dispositif de contrats MAERFF :

---

## APPENDIX 7:

### Description of the variables used in the econometric model (Chapter 4)

Variable	Description	Unit
<i>Farmers and farm socio-economic characteristics</i>		
AGE	Age of the farmer	Years
EDUC	Education	1=Superior or Secondary long 0= Primary or secondary short
SURF	Size of the farm as compared to other farmers with the same type of production	1 (resp. 0)=farm size superior (resp. inferior) to the average farm with the same type of production;
ORGA	Type of farming	1=Organic; 0=Other types
PROFIT	How do you judge the profitability of your activity?	1=Rather or very profitable 0=Not profitable or low profitability
ACTIVITY	Have you had important change in your farm in the last 5 years?: No modification Development of a new activity or size increase Activity decrease or retirement close	NEWACTIVITY=1 (0 otherwise) ACTIVITYRED=1 (0 otherwise)
SUCCESSOR	Do you believe someone will carry on farm activities after you retire?	1=Yes; 0=No
ADOPT	Have you already signed an ABOS contract?	1=Yes; 0=No
<i>Contract flexibility</i>		
FLEX	Flexibility perception index: sum of replies to: The diversity of measures is an advantage There are a lot of control Sanctions are reasonable It is possible to renegotiate the contract It is easy to disengage	Continuous: sum of variables below 1=Agree; 0=Disagree or no opinion 1=Disagree; 0=Agree or no opinion 1=Agree; 0=Disagree or no opinion 1=Agree; 0=Disagree or no opinion 1=Agree; 0=Disagree or no opinion
<i>Transaction costs</i>		
TC	Transaction costs perception index There is a need to invest in equipment Requires a large amount of time for administrative procedures Rules and requirements are easy to understand There is a need of a third person for implementation	Continuous: sum of variables below 1=Agree; 0=Disagree or no opinion 1=Agree; 0=Disagree or no opinion 1=Disagree; 0=Agree or no opinion 1=Agree; 0=Disagree or no opinion
<i>Intensity of change</i>		
EASE	Ease to change perception index. The proposed measures are: easy to implement on my farm fit well in my farming system an opportunity to exploit unused fields ...an opportunity to be supported for practices I had already adopted or planned to adopt	Continuous: sum of variables below 1=Agree; 0=Disagree or no opinion 1=Agree; 0=Disagree or no opinion 1=Agree; 0=Disagree or no opinion 1=Agree; 0=Disagree or no opinion

***Contract payment***

PAYMENT            The proposed payment level is interesting            1=Agree; 0=Disagree or no opinion

***Attitude towards the environment***

ENV                 The protection of threatened bird species is a priority for our area            1=Agree; 0=Disagree or no opinion

NATURE            Do you practice nature activity or are you member of a nature association?            1=Yes; 0=No

RESP                It is my responsibility, as a farmer, to act for the protection of threatened bird species            1=Agree; 0=Disagree or no opinion

***Social Norms***

INSTOPINON        What is the opinion of the Chambre d'Agriculture on ABOS, according to you?            1=Positive; 0=Negative or no opinion

NORMDESC         The fact that other farmers adopt ABOS is important to me.            1=Agree; 0=Disagree or no opinion

***Trust in institutions***

TRUST              I trust the institutions involved in the monitoring and implementation of ABOC            1=Agree; 0=Disagree or no opinion

TRUSTDEV         I trust that the developers that fund ABOS will respect their engagement            1=Agree; 0=Disagree or no opinion

***Attitude towards biodiversity offsets (BO)***

ATTITBO            What is your opinion on BO through agriculture?            1=Positive; 0=Negative or no opinion

*Other*

EFFIC              ABOS will lead to the protection of threatened bird species            1=Agree; 0=Disagree or no opinion

## APPENDIX 8:

### Example of a choice set (Chapter 5)

Caractéristique 1 Objectif de la mesure	<b>Mesure 1</b> Préservation 	<b>Mesure 2</b> Compensation 	<b>Aucune des 2 mesures</b>
Caractéristique 2 Seuil minimal de participation	Seuil minimal 	Pas de seuil 	
Caractéristique 3 Montant	260€/ha/an	200€/ha/an	

Cochez votre option préférée



## **APPENDIX 9:**

### **Traductions en français**

## **INTRODUCTION GENERALE**

« Non à l'écologie technocratique, oui au bon sens paysan »- le slogan scandé par les agriculteurs pendant les manifestations de 2014 en France, révèle une résistance culturelle forte du monde paysan à la place grandissante des objectifs environnementaux dans les politiques agricoles. Toutefois, bien qu'il y ait de plus en plus d'éléments portant à penser que les motivations des agriculteurs pour l'adoption de pratiques agricoles respectueuses de l'environnement ne sont pas uniquement basées sur un calcul économique, la politique agro-environnementale de l'Union a peu évolué au cours des 20 dernières années. Elle s'appuie principalement sur des mesures réglementaires et des incitations économiques tels que les Mesures Agro-environnementales (MAE). Durant la période budgétaire 2007-2013, le total des paiements effectués par l'Union Européenne (UE) pour les MAE s'élevait à 22,7 milliards d'Euros, qui ont été complétés par les pays membres de l'UE pour un montant équivalent .

L'hypothèse sous-jacente est que compenser les agriculteurs pour les coûts additionnels liés à l'adoption d'une pratique respectueuse de l'environnement est suffisant pour induire un changement. Cette approche néglige les forces sociales et psychologiques qui interviennent dans cette transformation de l'agriculture. Ceci a d'ailleurs conduit à des résultats décevants. Les évaluations des programmes de MAE ont montré que les taux de participation sont bas, particulièrement dans les zones d'agriculture intensive et que les objectifs environnementaux ne sont pas atteints. (Dobbs et Pretty ; 2008 ; Solagro, 2013). L'enjeu est donc de comprendre les raisons de cet échec et de mieux analyser les facteurs qui influencent le choix des agriculteurs entre différents types de pratiques, qui conduisent à des impacts environnementaux différents.

La littérature issue de l'Economie standard s'appuie sur l'hypothèse selon laquelle les agriculteurs agissent comme des agents économiques classiques et souhaitent changer leurs pratiques s'ils reçoivent un paiement compensatoire suffisant pour couvrir leurs coûts d'opportunité. En pratique, on observe que certains agriculteurs sont extrêmement réticents à passer à de nouvelles pratiques même quand les paiements proposés sont supérieurs aux coûts

additionnels et au manque-à-gagner (Kuhfuss et al. 2014). D'autres, au contraire, sont prêts à signer une MAE même s'ils ne sont pas complètement compensés pour leurs coûts. Il est donc nécessaire d'avoir une meilleure connaissance des raisons qui conduisent les agriculteurs à participer à une MAE. Quelles sont les raisons qui expliquent les différences entre prédictions de la littérature économique standard et le comportement réel ? Est-ce que l'efficacité et l'efficience des MAE pourraient être améliorés en comprenant ces raisons ?

L'Economie comportementale fournit un cadre théorique pour traiter ces questions : elle permet d'identifier les « biais » ou facteurs comportementaux, considérés comme des écarts systématiques du comportement humain aux prédictions de la théorie du choix rationnel (Shogren et Taylor, 2008) et propose d'enrichir les modèles de décision en introduisant ces facteurs comportementaux. Les résultats de l'économie comportementale peuvent aider à mettre au point des politiques qui sont mieux adaptées aux règles de décision des agents. L'Economie comportementale est d'ailleurs de plus en plus utilisée dans les sphères politiques. Malgré ce phénomène, l'Economie comportementale a jusqu'à présent été peu utilisée pour l'étude de l'adoption de pratiques respectueuses de l'environnement et la mise au point de politiques agro-environnementales.

L'objectif général de cette thèse est donc de mesurer l'importance des facteurs sociologiques et psychologiques dans les décisions des agriculteurs en matière d'environnement. Cette meilleure compréhension du comportement des agriculteurs pourra aider à mettre au point des incitations plus efficaces. La thèse mobilise l'économie comportementale, à travers différents travaux empiriques au laboratoire (Economie expérimentale) et sur le terrain (Enquête et expériences de choix).

La thèse traite de deux questions générales :

- Quel est le rôle des facteurs comportementaux dans l'adoption de Contrats Agro-Environnementaux (CAE) ?
- Quelle est la performance des dispositifs innovants de CAE et comment elle est affectée par les facteurs comportementaux ?

Traiter de ces questions est fondamental car des politiques agro-environnementales basées sur une meilleure connaissance pourraient améliorer l'impact des incitations. Ceci peut par exemple donner des idées sur la façon d'exploiter le rôle des facteurs comportementaux pour modifier les incitations. En outre, cela ouvrira la possibilité de mettre en œuvre des

interventions alternatives à faible coût, telles que les «nudges» (Thaler et Sunstein, 2008). Ces approches sont nécessaires dans un contexte où le poids financier de la politique agricole est régulièrement contesté au niveau européen.

L'article 1 de cette introduction présente un bref historique des CAE et les principaux problèmes auxquels ils sont confrontés. Dans la section 2, nous décrivons les principales théories comportementales utilisées pour analyser le comportement pro-environnemental, y compris pour les agriculteurs, et leur rôle croissant dans l'arène politique. La section 3 présente nos questions de recherche, ainsi que les hypothèses et la méthodologie que nous avons mobilisées.

## **1 Historique et principaux enjeux des CAE**

### **1.1 Bref historique des CAE**

Le principe des CAE est apparu dans les années 80 en Europe en réponse à deux problèmes de nature différente: 1) la reconnaissance croissante des externalités négatives sur l'environnement générées par l'intensification agricole et ii) la nécessité de trouver une justification acceptable pour les subventions agricoles dans les négociations de l'OMC (Hanley et al, 1999; Hodge, 2013). La possibilité d'inclure des paiements nationaux dans les zones écologiquement sensibles a été introduite dans l'Union européenne en 1985, mais les CAE, en tant que tels, ont été introduits dans la PAC lors de la réforme Mac Sharry en 1992. Depuis la réforme de l'Agenda 2000, il est obligatoire pour les États membres d'inclure des CAE, appelés Mesures Agro-environnementales (MAE), dans leurs plans de développement rural, ainsi que l'écoconditionnalité. Pour obtenir le soutien financier de la PAC, les agriculteurs doivent se conformer à un ensemble de «bonnes conditions agro-environnementales » (BCAE) en termes de préservation de la qualité de l'eau et des sols qui forment un niveau de référence. Les MAE sont proposées dans des zones géographiques qui présentant des problèmes environnementaux majeurs: elles proposent des contrats individuels qui offrent une compensation financière à des agriculteurs volontaires pour leur adoption de pratiques agricoles favorables à l'environnement plus exigeantes que les BCAE. Les paiements MAE sont versés annuellement et leur montants couvrent les surcoûts et manques-à-gagner résultant des engagements pris et, le cas échéant, peuvent également couvrir des coûts de transaction (règlement CE/1698/2005). Les paiements ne sont toutefois pas différenciés en fonction des coûts d'opportunité individuels. Il s'agit de paiements fixes, dont

le montant est déterminé à l'aide de données d'une "ferme moyenne" dans chaque région. Les contrats peuvent durer de 5 à 7 ans.

Parallèlement au développement des MAE en Europe, les Paiements pour Services Environnementaux (PSE) ont été mis en œuvre à grande échelle dans les pays en développement. Des programmes de PSE ont été mis en place dans différentes régions du monde comme par exemple des programmes PSE à l'échelle nationale au Costa Rica (Pagiola, 2008) et au Mexique (Muñoz-Piña et al., 2008), des PSE sur l'utilisation de la forêt à Madagascar (Sommerville et al., 2010) et des PSE pour l'érosion des sols en Chine (Chen et al., 2009). La définition du PSE est un sujet de controverse dans la littérature, nous considérons cependant la définition de référence de Wunder (2005). Un PES est :

1. une transaction volontaire dans laquelle
2. un service environnemental bien défini (ou un usage du sol susceptible de fournir ce service)
3. est «acheté» par un ou plusieurs acheteurs
4. à un ou plusieurs fournisseurs de service environnemental
5. si et seulement si le fournisseur de service environnemental garantit la fourniture de ce service environnemental (conditionnalité).

Les MAE peuvent être considérés comme des PSE financés par l'Etat : une administration publique centralisée agit comme seul acheteur des services environnementaux pour le compte des utilisateurs finaux (Engel et al, 2008; Wunder et al., 2008). Nous parlerons par la suite du terme général de Contrats Agro-Environnementaux (CAE)

## **1.2 Enjeux des CAE**

Les CAE font face à un certain nombre de problèmes dans leur mise en œuvre. Ces problèmes ont été largement étudiés dans la littérature économique. Nous effectuons ici une présentation générale des problèmes des CAE qui sert deux objectifs. D'abord, nous décrivons les principales conclusions des approches économiques classiques et nous identifions des questions non traitées pour lesquelles les approches comportementales peuvent fournir un nouvel éclairage, telles que la question de la participation aux CAE. Deuxièmement, nous mettons en évidence certains des principaux problèmes qui affectent l'efficacité et l'efficience des CAE. Nous présentons ici en particulier les problèmes liés aux asymétries d'information et au manque de coordination entre agriculteurs. Ce second aspect de notre revue de littérature

est important car 1) un des dispositifs innovants que nous étudions dans cette thèse traite spécifiquement du problème du manque de coordination et 2) cet inventaire des problèmes d'efficacité et d'efficience sert de cadre pour l'analyse les performances des CAE appliqués à la compensation écologique, un des dispositifs innovants que nous étudions.

### **1.2.1 Le problème de la participation**

Le niveau de participation dans les CAE étant l'un des facteurs clés pour assurer un impact significatif sur l'environnement, la recherche empirique s'est largement intéressée aux déterminants cette participation. Les principaux déterminants mis en évidence dans la littérature économique sont les suivants: (a) les caractéristiques socio-économiques des agriculteurs et des exploitations, (b) les caractéristiques du contrat et (c) les niveaux de paiement et les coûts de transaction. L'hypothèse sous-jacente de ces études est issue de l'approche économique standard : les agriculteurs adoptent un CAE si leur contrainte de participation est remplie, c'est à dire si les paiements sont supérieurs aux coûts d'opportunité des agriculteurs (par exemple Moxey et al., 2008). Les déterminants identifiés dans la littérature sont donc supposés être des facteurs de la fonction de coût de l'exploitation pour la mise en œuvre les pratiques agricoles prescrites dans le contrat.

#### **a) Les facteurs socio-économiques des exploitations et des agriculteurs**

La taille des exploitations, l'âge des agriculteurs et le niveau d'éducation sont considérés, dans la littérature, comme les principaux facteurs socio-économiques qui influent l'adoption de CAE. Plus précisément, les CAE sont généralement adoptés dans de grandes exploitations (Morris et Potter, 1995; Wilson, 1997; Falconer, 2000a; Allaire et al., 2009). Les jeunes agriculteurs sont généralement plus susceptibles d'adopter des CAE (Morris et Potter, 1995; Bonnieux et al., 1998; Wynn et al., 2001; Vanslebrouck et al, 2002a;. Ruto et Garrod, 2009; Ducos et al., 2009; Chabé-Ferret et Subervie, 2013) à moins que le contrat prévoit l'adoption de pratiques d'extensification (Drake et al., 1999). Enfin, les agriculteurs ayant un niveau d'enseignement supérieur ont tendance à être plus intéressés par ces contrats (Wilson, 1997; Allaire et al, 2009; Louis et Rousset, 2010; Chabé-Ferret et Subervie, 2013).

L'attitude envers le risque est également un facteur clé de l'adoption de CAE. L'aversion au risque influence donc l'adoption, mais de deux façons opposées. Tout d'abord de façon positive, grâce au revenu stable que représentent les paiements des CAE (Fraser, 2004). Certains agriculteurs peuvent même vendre des services environnementaux à des niveaux de

paiement inférieurs aux coûts d'opportunité afin de réduire l'instabilité de leur revenu (Fraser, 2004; Karsenty et al., 2010). Néanmoins, Slangen (1997) et Sumpsi et al. (1998) montrent que les incertitudes sur l'avenir des politiques agro-environnementales et sur l'impact des pratiques sur la production agricole peuvent limiter la participation des agriculteurs.

### **b) Les caractéristiques du contrat**

La flexibilité du contrat est un critère important dans l'adoption de CAE par les agriculteurs. Les contrats qui sont les plus susceptibles d'être adoptés ont une durée plus courte (Bougherara et Ducos, 2006; Ruto et Garrod, 2009; Louis et Rousset, 2010; Christensen et al, 2011), laisse plus de flexibilité aux agriculteurs dans le choix des parcelles (Bougherara et Ducos, 2006; Ruto et Garrod, 2009) et dans le cahier des charges techniques (Bougherara et Ducos, 2006; Ruto et Garrod, 2009; Christensen et al, 2011; Kuhfuss et al, 2014). De plus, la facilité de rupture du contrat est également un critère important pour la participation des agriculteurs (Christensen et al., 2011).

### **c) Le niveau de paiement et les coûts**

Le niveau de paiement proposé dans le CAE par rapport aux coûts individuel d'opportunité et de mise en œuvre est un facteur d'adoption majeur (Brotherton, 1991; Drake et al., 1999). Comme mentionné précédemment, ces paiements peuvent également être perçus comme une source de revenu garantie (Wilson et Hart, 2001).

Les coûts de transaction ont également un fort impact sur l'adoption de CAE par les agriculteurs (Falconer, 2000b; Ducos et Dupraz, 2007a; Peerlings et Polman, 2009; Vatn, 2010). Des coûts de transaction élevés (réels ou perçus) peuvent représenter des obstacles à la participation des agriculteurs aux CAE. La spécificité des actifs, c'est-à-dire des investissements spécialisés qui ne peuvent pas être facilement redéployés pour une autre transaction, influencent notamment les coûts de transaction. Une spécificité élevée des actifs conduit à des coûts de transaction forts (Ducos et Dupraz, 2007a; Rørstad et al., 2007). La confiance entre les partenaires contractuels facilite également la participation dans les CAE en réduisant les coûts de transaction à la fois avant et pendant la transaction (Ducos et Dupraz, 2007a; Ducos et al, 2009; Peerlings et Polman, 2009; Louis et Rousset, 2010).

L'expérience de pratiques similaires résultant d'une participation antérieure à un autre type de CAE a également un effet positif sur l'adoption (Allaire et al, 2009; Louis et Rousset, 2010;

Chabé-Ferret et Subervie, 2013). Cette expérience peut effectivement réduire les coûts de mise en œuvre et les coûts de transaction (Kuhfuss et al., 2013).

Bien que bon nombre de ces facteurs puissent en effet être inclus dans une fonction de coût, le fondement théorique de l'influence de caractéristiques telles que l'âge ou l'éducation est plutôt faible. L'influence de ces variables pourrait bien se faire à travers des variables médiatrices comportementales qui ne sont généralement pas incluses dans ces études.

Il y a relativement peu de preuves directes du rôle des facteurs comportementaux dans l'adoption des CAE dans la littérature économique. Le facteur comportemental le plus étudié, en psychologie sociale toutefois, est le rôle de la préférence pour l'environnement. Souvent présentée comme l'influence de « l'attitude envers l'environnement », il a été montré qu'elle influe la participation à des programmes agro-environnementaux dans plusieurs contextes (Morris et Potter, 1995; Delvaux et al, 1999; Beedell et Rehman, 2000a; Defrancesco et al. 2008; Ducos et al, 2009; Mzoughi, 2011). Les agriculteurs participant à des associations environnementales et ayant des activités liées à la nature sont également plus susceptibles de participer à des programmes agro-environnementaux (Beedell et Rehman, 2000a). La sensibilité environnementale semble être principalement importante pour les mesures qui nécessitent le plus d'efforts par les agriculteurs (Delvaux et al., 1999; Vanslebrouck et al., 2002a).

L'effet des facteurs comportementaux sur l'adoption des CAE a donc été peu étudiée. Une des contributions de cette thèse est de contribuer à combler cette lacune.

### ***1.2.2 Problèmes liés aux asymétries d'information***

La recherche théorique en économie sur les CAE mobilise principalement la théorie des contrats. Le contrat est considéré comme une relation principal-agent entre un fournisseur d'un service environnemental (l'agriculteur ou le propriétaire foncier) et un acheteur (l'Etat pour les MAE et d'autres acheteurs potentiels pour PES). Cette relation contractuelle est caractérisée par une asymétrie d'information – les agents (agriculteurs) ont plus d'informations que l'agence (l'État pour les MAE) - et des objectifs différents - les agriculteurs veulent maximiser leur profit et l'Etat veut maximiser le bien-être social. Les agriculteurs peuvent exploiter cette asymétrie d'information pour en extraire une rente informationnelle (Ferraro, 2008).

Deux problèmes principaux d'asymétrie d'information se posent. Le premier problème est que les agriculteurs ont plus d'informations sur leurs coûts d'opportunité (informations cachées) pour se conformer aux prescriptions techniques du contrat. Ils peuvent donc essayer de négocier des paiements plus élevés que leurs coûts. De même, dans le cas des contrats avec des paiements standard et constant par hectare, ce qui est la règle générale pour les MAE, il existe un fort potentiel de sélection adverse (Fraser, 2009; Chabé-Ferret et Subervie, 2013). La sélection adverse conduit à choisir les agriculteurs présentant les coûts d'opportunité les plus faibles. Cela peut ne pas être un problème si les coûts d'opportunité sont corrélés négativement avec les bénéfices environnementaux, mais dans la plupart des cas, cette corrélation est non vérifiée (Claassen et al., 2008). De plus, le système de paiement uniforme conduit à une surcompensation des agriculteurs ayant les coûts les plus bas. Dans le pire des cas, les CAE peuvent attirer des agriculteurs avec des coûts d'opportunité nuls, c'est à dire qui adopteraient les pratiques sans l'existence de CAE et sont néanmoins payés. Dans ce cas, l'effet additionnel du programme agro-environnemental est nul ou très limité : on parle d'effet d'aubaine (Chabé-Ferret et Subervie, 2013; Kuhfuss et Subervie, 2015). Trois solutions sont proposées dans la littérature pour résoudre ce problème: (1) obtenir des informations sur les bénéfices environnementaux que les agriculteurs peuvent potentiellement fournir et les sélectionner sur cette base; (2) proposer aux agriculteurs un menu de contrats permettant de révéler leurs coûts; et (3) allouer les contrats par le biais d'enchères agro-environnementales (Ferraro, 2008).

Le deuxième problème lié à l'asymétrie d'information est que les agriculteurs sont mieux informés de leurs actions que l'acheteur (action cachée), ce qui conduit à un problème d'aléa moral. D'une part, le fournisseur de service environnemental est incité à ne pas respecter les termes du contrat mais plutôt un niveau de conformité qui lui est économiquement optimal. D'autre part, l'acheteur ne peut pas forcer le fournisseur à respecter les termes du contrat en raison des coûts de contrôle (Wu et Babcock, 1996). Un des moyens possibles pour résoudre le problème d'aléa moral est de conditionner le paiement des contrats aux résultats environnementaux plutôt qu'aux actions. Ce système de CAE avec paiement aux résultats a l'avantage de donner une incitation directe aux agriculteurs à la fourniture des services environnementaux. Ce type de contrat transfère toutefois à l'agriculteur le risque d'une absence de résultat environnemental, qui peut être dû à des aléas naturels dont l'agriculteur n'est pas responsable. Les agriculteurs peuvent donc être enclins à ne pas accepter ce risque et ainsi ne pas adopter ce type de contrat (Zabel et Roe, 2009; Matzdorf et Lorenz, 2010).

### ***1.2.3 Le problème de la coordination des agriculteurs à l'échelle du paysage***

Les contrats volontaires avec paiement uniforme, qui sont les plus communément utilisés, ne prévoient pas de mécanismes pour assurer une coordination spatiale des efforts environnementaux à l'échelle du paysage. Cette coordination est toutefois souvent essentielle pour avoir un impact significatif sur l'environnement (Goldman et al., 2007). Par exemple, la conservation des espèces menacées nécessite généralement la création ou la protection d'habitats naturels en forme de corridors, de mosaïques ou de continuum qui recouvrent plusieurs exploitations (Forman, 1995). L'une des principales innovations proposées pour traiter le problème du manque de coordination des agriculteurs à l'échelle du paysage est l'utilisation d'une prime d'agglomération. La performance de ce mécanisme a été testée empiriquement principalement dans des expériences de laboratoire (Parkhurst et al., 2002; Warziniack et al, 2007;. Parkhurst et Shogren, 2007; Banerjee et al, 2012) et dans des simulations mathématiques (Drechsler et al, 2010; Bamière et al, 2013).

Outre les questions de coordination spatiale, un autre type de problème de coordination peut se produire en présence de seuil environnemental. Ce problème de coordination apparaît lorsque l'effort environnemental (en termes de pratiques améliorées) n'atteint pas une superficie suffisante dans la zone d'intérêt pour atteindre le seuil environnemental et obtenir un effet environnemental significatif (Dupraz et al., 2009). Dans cette thèse, nous allons notamment tester les performances d'un contrat innovant conçu pour résoudre ce problème de coordination.

Cette section a brièvement souligné les problèmes associés aux CAE identifiés par l'économie standard. Dans cette thèse, nous avons l'intention d'utiliser des approches comportementales pour répondre à certains des problèmes des CAE présentés ci-dessus et également pour étudier des dispositifs innovants de CAE. La section suivante présente les approches comportementales et la façon dont elles ont été appliquées à l'étude des comportements pro-environnementaux.

## **2 Les approches comportementales des décisions pro-environnementales**

Les approches comportementales sont de plus en plus utilisées pour analyser le comportement pro-environnemental en économie. Bien que ce soit une tendance émergente en économie, la

psychologie sociale étudie les comportements pro-environnementaux depuis de nombreuses années avec des concepts proches. Dans cette section, nous présentons les grands principes de ces approches comportementales et leur application à l'étude des comportements pro-environnementaux.

## **2.1 L'économie comportementale**

L'Economie comportementale applique des concepts issus de la psychologie dans le domaine de l'économie. L'ambition est d'enrichir les modèles économiques pour mieux expliquer et prédire le comportement humain. L'Economie comportementale explore, catalogue et rationalise les écarts systématiques entre comportements réels et prédictions de la théorie du choix rationnel (Shogren et Taylor, 2008).

Mullainathan et Thaler (2000) classent les facteurs comportementaux en trois catégories principales: la rationalité limitée, la volonté limitée, et l'intérêt limité. La rationalité limitée signifie que les gens n'ont pas des capacités illimitées de traitement de l'information (Simon, 1955) et utilisent plutôt des heuristiques qui conduisent à des biais systématiques dans leurs jugements (croyances) et dans leurs choix. Par exemple, les individus peuvent être soumis à l'aversion aux pertes, des effets du contexte, des effets de richesse.... La volonté limitée signifie que les agents peuvent prendre des décisions qu'ils savent ne pas être dans leur intérêt (manger et boire trop, tromper leur femme ...) en raison du manque de maîtrise de soi. Enfin, l'intérêt limité signifie que les agents ont des préférences sociales telles que l'altruisme, l'équité, les normes et aversion à l'inégalité qui interviennent dans leurs décisions au même titre que les gains financiers (Mullainathan et Thaler, 2000; Shogren et al., 2010).

L'Economie comportementale est-elle pertinente pour étudier des questions environnementales? L'hypothèse du comportement rationnel est en grande partie liée à l'existence d'un marché actif qui permet une allocation optimale des ressources (Arrow, 1986). Faire l'hypothèse d'un comportement de choix rationnel peut donc être problématique en matière d'environnement où les arbitrages basés sur le marché sont généralement absents (Crocker et al., 1998). Les biens environnementaux sont en effet souvent des biens publics dont la production dépend de nombreux facteurs socio-psychologiques (par exemple Shang et Croson, 2009). De plus, les problèmes environnementaux sont souvent associés à de forts sentiments moraux et sont caractérisés par un niveau élevé de complexité qui favorise l'influence des phénomènes de rationalité limitée (Croson et Treich, 2014). Shogren et Taylor (2008) font le parallèle entre les défaillances de marché et les « défaillances

comportementales » sur les problèmes environnementaux. Ceci conduit selon eux à un nouveau problème de « second best » et milite pour l'émergence d'une «Economie de l'Environnement Comportementale ». L'une des conséquences de l'Economie comportementale a été l'émergence de nouveaux instruments de politique tels que les « nudges » (Thaler et Sunstein, 2008). L'idée de base est que le comportement peut être modifié par une modification subtile du contexte de décision, souvent désigné comme l'architecture du choix. Les exemples les plus connus de nudges sont ceux basés sur une comparaison sociale de la consommation d'énergie (Allcott, 2011) ou de la réutilisation de serviettes dans les hôtels (Goldstein et al., 2008).

Dans un premier temps, l'Economie de l'environnement s'est intéressée au rôle des facteurs comportementaux dans les évaluations environnementales : biais hypothétique, biais d'ancrage, effet du contexte... (Cummins et al., 1986). Au cours des dernières décennies, le développement de l'économie expérimentale a permis de tester les prédictions et les hypothèses de la théorie économique standard et a largement conduit à les remettre en cause. Un exemple qui a de fortes implications en Economie de l'environnement est la vaste littérature sur les biens publics et les biens communs (par exemple Ledyard, 1995; Ostrom, 2006).

Les "nudges verts", c'est-à-dire des nudges qui visent à promouvoir un comportement respectueux de l'environnement, ont de plus en plus été testés au cours des dernières années, soit expérimentalement soit dans des interventions pilotes. Schubert (2016) propose de classer ces nudges en trois catégories: les nudges verts qui capitalisent sur le désir des consommateurs d'avoir une bonne image d'eux-mêmes en rendant les caractéristiques écologiques des produits plus saillantes (éco-labels, la Toyota Prius), les nudges verts qui exploitent la tendance des gens à « suivre le troupeau » et les nudges vert qui exploitent la volonté limitée, comme par exemple en modifiant délibérément les choix par défaut entre les différents produits ou services.

Déterminer comment la performance des mécanismes d'incitation traditionnels recommandés par l'Economie de l'environnement (taxes, subventions, permis négociables ...) est affectée par des facteurs comportementaux est une branche moins explorée. C'est l'impact de l'intérêt limité qui est le plus analysé dans cette littérature. Ainsi, Ariely et al (2009) définit que les agents peuvent avoir des motivations différentes de se comporter de façon pro-sociale, qui peuvent être divisées en trois catégories: motivations extrinsèques, intrinsèques et d'image.

Les motivations extrinsèques représentent les récompenses matérielles associées au comportement pro-social. Cette motivation est celle traditionnellement étudiée dans la recherche qui ne tient compte que des motivations monétaires. Les incitations monétaires généralement incluses dans les politiques environnementales ciblent ces motivations extrinsèques. La motivation intrinsèque représente la préférence individuelle pour le bien-être des autres. Des exemples de telles motivations sont l'altruisme pur, ou la préférence pour l'environnement. Enfin, la motivation d'image est associée à la tendance à être influencé par l'opinion des autres ou approbation sociale, tels que l'influence des normes sociales. Ces trois motivations peuvent interagir les unes avec les autres et influencer l'efficacité des incitations monétaires utilisées pour promouvoir un comportement pro-social. L'exemple le plus célèbre est l'introduction d'incitations monétaires pour le don de sang qui ont eu dans les faits un impact négatif sur ce comportement pro-social (Titmuss, 1970; Mellström et Johannesson, 2008). Lorsque les incitations monétaires ont des interactions négatives avec la motivation intrinsèque, on parle d'effet d'éviction, tandis que si elles ont des interactions positives on dit qu'elles renforcent les motivations intrinsèques. Par exemple, Benabou et Tirole (2006) élabore un modèle qui détermine comment les incitations à adopter un comportement pro-social peuvent être déterminées, étant donné que les individus sont altruistes, ont des préoccupations réputationnelles, et que les incitations monétaires peuvent partiellement les évincer. Un autre exemple est l'article de Nyborg (2010) qui analyse les cas où les taxes environnementales peuvent renforcer ou évincer des motivations morales.

## **2.2 Le comportement pro-environnemental en psychologie sociale**

La psychologie sociale est une autre discipline des sciences sociales qui a beaucoup étudié le comportement pro-environnemental, y compris le comportement des agriculteurs. Les deux théories les plus influentes et empiriquement utilisées dans cette discipline sont les théories de la motivation morale et la théorie du comportement planifié (Turaga et al., 2010).

### **2.2.1 Théories de la motivation morale**

Shalom Schwartz (1977; 1978) est à l'origine des théories de la motivation morale avec la théorie de l'activation de la norme. Cette théorie, développée initialement pour étudier les comportements pro-sociaux tels que le volontariat, estime que les normes personnelles influencent ce type de comportement et doivent être activées pour avoir une influence. Deux conditions sont nécessaires pour que ces normes soient activées, l'individu doit i) être conscient que son action a une influence sur le bien-être des autres ("Connaissance des

conséquences» (CC)) et ii) l'individu doit éprouver une responsabilité personnelle à entreprendre le comportement pro-social («attribution de la responsabilité» (AR)). Quand ces deux conditions sont activées, elles créent un sentiment d'obligation morale d'entreprendre le comportement. Ce sentiment peut néanmoins être neutralisé par d'autres facteurs. En effet l'adoption d'un comportement pro-social peut parfois être coûteux et un individu peut se «défendre» lui-même en niant ce sentiment d'obligation morale. C'est seulement quand le sentiment d'obligation morale compense les coûts non-moraux associés au comportement pro-social que le comportement est effectivement adopté (Turaga et al., 2010). En matière d'environnement, la théorie d'activation de la norme a été principalement utilisée pour expliquer les comportements de gestion des déchets, tels que le recyclage (Liere et Dunlap, 1978; Hopper et McCarlnielsen, 1991; Vining et Ebreo, 1992; Bratt, 1999). Cette théorie a été élargie avec la théorie Valeurs-Croyances-Normes (Stern et al., 1999) pour une application à l'action environnementale. La théorie Valeurs-Croyances-Normes considère que les conditions CC et AR sont façonnées par des croyances générales sur les interactions homme-environnement, telles que celles testées dans le Nouveau Paradigme Ecologique de Dunlap et Van Liere (1978) et un ensemble de valeurs humaines fondamentales telles que le dépassement de soi, l'auto-amélioration et la tradition (Turaga et al., 2010). Cette théorie semble avoir un bon pouvoir explicatif des comportements de citoyenneté environnementale tels que la signature d'une pétition, mais beaucoup moins pour des comportements plus coûteux tels que le comportement des consommateurs, pour lesquels le contexte et les facteurs externes ont plus d'influence (Turaga et al., 2010). La Théorie du Comportement Planifié qui tient compte de ces facteurs a pris une grande importance depuis plusieurs décennies.

### **2.2.2 La Théorie du Comportement Planifié (TCP)**

La théorie issue de la psychologie sociale qui a été le plus largement utilisée dans l'étude des comportements pro-environnementaux est la TCP (Ajzen, 1991). Le principe de base de cette théorie est que l'intention d'adopter un comportement est considérée comme le principal facteur prédictif du comportement. Les intentions permettent d'évaluer les motivations pour l'adoption d'un comportement, autrement dit elles sont une indication des efforts que les individus sont prêts à exercer, pour adopter un comportement. Plus l'intention est forte, plus il est probable que le comportement sera adopté. La TCP considère trois déterminants indépendants de l'intention. La première est l'**attitude** à l'égard du comportement et se réfère à «la mesure dans laquelle une personne a une évaluation favorable ou défavorable du comportement en question». La seconde, la **norme subjective**, représente la «pression sociale

perçue pour adopter ou de ne pas adopter le comportement". Le troisième facteur, le contrôle perçu, se réfère à «la facilité ou la difficulté perçue pour adopter le comportement".

A partir de cette formulation initiale de la théorie, le modèle a été élargi pour inclure les normes sociales, les normes descriptives personnelles et le comportement passé (voir le chapitre 1 pour plus de détails sur cette théorie). Elle a été largement appliquée et testée empiriquement pour expliquer de nombreux comportements, y compris le comportement pro-environnemental (voir Armitage et Conner, 2001 pour une revue). Un des avantages de cette théorie est qu'elle intègre les effets de plusieurs facteurs comportementaux plutôt que de les étudier un par un comme dans le cas de l'économie comportementale (Kahneman, 2003). Un deuxième avantage est qu'elle fournit une approche normalisée pour évaluer les variables comportementales dans des enquêtes de préférences déclarée. Cette approche a été largement utilisée et a généré de nombreux retours d'expérience. Enfin, cette théorie considère qu'un ensemble de croyances détermine l'attitude (les résultats attendus du comportement), le contrôle perçu (contraintes et opportunités attendues du comportement) et les normes injonctives (opinion perçue des personnes importantes pour l'individu). Eliciter ces croyances peut aider à identifier des leviers potentiels pour influencer le changement de comportement.

### **2.3 Le rôle croissant des approches comportementales dans les politiques environnementales**

Les approches comportementales ont pris une ampleur considérable au cours des dernières années dans le domaine politique. De nombreux pays et organisations internationales ont commencé à mobiliser les sciences comportementales pour élaborer des politiques publiques.

Le mouvement a commencé au Royaume-Uni en 2009, avec la création de l'équipe « Behavioral insights », rattachée au bureau du Premier ministre. Cette institution est dédiée à l'application des sciences du comportement dans les politiques publiques avec pour objectif d'améliorer leur efficacité et de permettre aux individus de "faire de meilleurs choix pour eux-mêmes". Sur les questions environnementales, cet institut a publié un document de stratégie nommée « changement de comportement et utilisation de l'énergie » qui décrit un certain nombre d'expérimentations sur le terrain de nudges verts ayant pour objectif de réduire la consommation d'énergie. Aux Etats-Unis, Cass Sunstein a été nommé en 2009 Chef du Bureau « Information and Regulatory affairs » de la Maison Blanche (OIRA). Depuis lors, les approches comportementales ont pris de l'importance dans les politiques des États-Unis, qui s'est traduite par un décret exécutif présidentiel de Barack Obama publié en Septembre 2015

intitulé «Using Behavioral Insights to Better Serve the American People" qui encourage fortement les administrations fédérales à utiliser l'économie comportementale dans la conception et la mise en œuvre des politiques. L'OCDE mène un projet appelé «économie comportementale et expérimentale pour la politique environnementale» qui vise à utiliser les apports de l'économie comportementale pour améliorer la politique environnementale. Ce projet, entre autres, gère une base de données d'études en économie comportementale à l'usage des praticiens et des décideurs. Enfin, le rapport de la Banque mondiale 2015 "Mind, Society and Behavior" illustre également cette tendance. En France cependant, l'utilisation de l'économie comportementale reste anecdotique. La principale contribution est le rapport "Nudges verts: nouvelles incitations pour un comportement écologique», publié par le Centre d'Analyse Stratégique attaché au bureau du ministre Premier (Oullier et Sauneron, 2011). Une tribune appelant à une utilisation plus large de l'économie comportementale dans les politiques publiques françaises a été publiée dans Le Monde en 2015 par Elsa Savourey et Cass Sunstein (2015).

Dans le domaine des politiques agro-environnementales, les sciences du comportement ont été peu utilisées jusqu'à présent, à part au Royaume-Uni. Le Defra est un précurseur dans l'utilisation des approches comportementales depuis 2005. Il a commandé un certain nombre de rapports sur la question afin de faire le point sur la littérature existante et de mettre au point une stratégie basée sur les approches comportementales. Une grande partie du travail est ciblé sur le comportement des consommateurs, mais un effort particulier a également été fait sur la compréhension du comportement des agriculteurs et comment il pourrait être modifié (Defra, 2008). Leur modèle de comportement, fortement influencé par la TCP, considère que le comportement est influencé par i) des facteurs internes, qui comprennent l'attitude, les habitudes et le comportement passé, 2) des facteurs externes, qui comprennent les conditions du marché, les coûts et les interventions traditionnelles de politiques basées sur des incitations et la réglementation et 3) des facteurs sociaux avec notamment les normes sociales. Le Defra estime que ces différentes motivations doivent être abordées afin de parvenir à un changement durable de comportement. Une approche comportementale était déjà résumée dans la stratégie de développement durable du Royaume-Uni "Securing the future" (DEFRA, 2005). Cette stratégie prévoit que pour que les interventions gouvernementales soient efficaces et durables, elles présentent une approche équilibrée tenant compte des facteurs à la fois internes et externes à travers 4 types d'action : « Encourager » (incitations), « Faciliter » (en renforçant les infrastructures et des institutions), « Engager » (en influençant les motivations internes) et

Illustrer (en mettant en avant les exemples de réussites). Les mesures politiques qui ont pour objectif d' « encourager » ou de « faciliter » ciblent plutôt les motivations externes alors que les mesures de politique dont l'objectif est d' « engager » ou d'«illustrer» ciblent plutôt les motivations internes et sociales. Enfin, le Defra a également étudié l'hétérogénéité des agriculteurs, en considérant que les différents segments de la population répondent à différents types d'interventions (Collier et al., 2010). La typologie a été établie sur la base de deux enquêtes. Une première, qui portait sur 683 agriculteurs, réalisée par l'Université de Reading (2006), qui était essentiellement basée sur la TCP qui a été complétée par une seconde étude réalisée par Continental Research à partir d'un sondage téléphonique auprès de 750 agriculteurs (Defra, 2008).

Cinq segments, ou types d'exploitations, ont été identifiés en utilisant des méthodes d'analyse quantitative:

- Les exploitants traditionnels (23%) pour lesquels l'agriculture est un mode de vie profondément enraciné dans leur identité.
- Les exploitants qui privilégient la qualité de vie (6%) pour lesquels l'agriculture est la principale source de revenus mais pas la seule et qui voit l'agriculture comme une source d'accomplissement.
- Les exploitants pragmatiques (22%) qui représentent une catégorie intermédiaire qui a un lien affectif avec l'agriculture, mais reconnaissent la nécessité de se concentrer sur l'aspect entrepreneurial.
- Les entreprises familiales modernes (41%) pour qui l'activité agricole est une activité entrepreneuriale.
- Les entreprises en difficulté (7%) pour lesquels l'agriculture est un fardeau hérité par obligation familiale qui présentent des ressources limitées et des coûts importants.

D'un point de vue général, les exploitants traditionnels et ceux qui privilégient la qualité de vie réagissent plus aux interventions comportementales tandis que les entreprises familiales modernes et les entreprises en difficulté peuvent être plus réactives aux incitations monétaires. Les exploitants pragmatiques peuvent être sensibles à ces deux types d'interventions.

Les approches comportementales présentées dans cette section ne sont pas encore prises en compte dans les politiques agro-environnementales européennes, en particulier dans la conception et la mise en œuvre des CAE. L'objectif de cette thèse est de combler cette lacune et d'analyser le rôle des facteurs comportementaux dans la performance des CAE.

### 3 Questions de recherche, hypothèses et méthodes

Comme mentionné précédemment, notre recherche est organisée autour de deux grandes questions:

1. Quel est le rôle des facteurs comportementaux dans l'adoption de CAE?
2. Quelle est la performance des dispositifs innovants de CAE et comment elle est affectée par les facteurs comportementaux?

Pour chacune de ces deux questions, nous mettons en évidence nos questions de recherche spécifiques, nos hypothèses, la méthodologie que nous avons utilisée et enfin comment ces questions de recherche sont traitées dans cette thèse.

#### 3.1 Quel est le rôle des facteurs comportementaux dans l'adoption de CAE?

Cette question est abordée dans la partie I de la thèse. Deux questions de recherche spécifiques sont examinées.

##### ***3.1.1 Question de recherche 1: Est-ce que les facteurs comportementaux interviennent dans l'adoption de CAE?***

Notre hypothèse est que les facteurs comportementaux interviennent en effet dans la décision des agriculteurs de participer aux CAE. Bien qu'ils soient des entrepreneurs agricoles, les agriculteurs ne sont pas seulement des maximisateurs de profit, mais sont également influencés par des facteurs comportementaux dans leurs décisions agricoles.

Cette question de recherche est importante d'un point de vue politique, pour concevoir des contrats qui seront plus facilement approuvés par les agriculteurs et qui peuvent avoir des effets plus durables. Elle présente également des enjeux théoriques pour la conception de modèles de décision qui permettent prévoir de façon plus réaliste le comportement des agriculteurs. Elle suscite enfin des enjeux empiriques sur la façon de mesurer réellement l'impact de ces facteurs, difficilement observables, dans les décisions des agriculteurs.

L'objectif de ce travail est d'analyser la participation aux CAE et non pas directement l'adoption de pratiques favorables à l'environnement. Notre hypothèse est que les facteurs comportementaux seuls peuvent prédire les comportements pro-environnementaux qui entraînent des coûts relativement limités tels que le recyclage, la réutilisation des serviettes, mais ne sont pas aussi bons pour prédire les décisions qui entraînent des coûts plus élevés.

L'adoption de nouvelles pratiques agricoles, telles que la modification des pratiques de gestion des mauvaises herbes pour réduire l'utilisation des pesticides, peut exiger des investissements et des coûts importants qui peuvent conditionner la rentabilité de l'activité agricole. Nous supposons donc qu'encourager les agriculteurs à adopter ces pratiques exige une combinaison d'incitations économiques et de facteurs comportementaux. L'étude de l'impact des facteurs comportementaux sur l'adoption des CAE nous a donc semblé une voie plus prometteuse pour assurer finalement une adoption plus large des pratiques favorables à l'environnement. En outre, les facteurs comportementaux qui influencent l'adoption de CAE peuvent être différents de ceux qui sont impliqués dans l'adoption d'une pratique pro-environnementale. L'adoption de CAE provoque un certain nombre de conséquences, différentes de celles liées à l'adoption d'une pratique pro-environnementale, qui peuvent mobiliser l'influence de facteurs comportementaux spécifiques: perte d'indépendance liée aux termes du contrat, augmentation de la charge administrative...

Plusieurs facteurs comportementaux pourraient affecter la participation aux CAE. En terme de « rationalité limitée », les préférences des agriculteurs peuvent de la formulation des contrats CAE. Par exemple, les préférences des agriculteurs pour l'adoption d'un contrat peuvent être affectés par la formulation de l'objectif du CAE qui pourrait être "pour améliorer la qualité de l'eau» ou de «réduire la pollution générée par les activités agricoles». En termes de « volonté limitée », certains agriculteurs peuvent savoir que l'adoption d'un CAE serait dans leur intérêt parce que le paiement est au-dessus de leurs coûts, mais néanmoins peuvent renoncer en raison d'une « phobie administrative ». Enfin, l'« intérêt limité » peut notamment intervenir dans l'adoption de CAE avec l'influence possible de différents facteurs dans l'adoption: les normes sociales, les normes personnelles pour l'environnement. Nous nous concentrons particulièrement dans ce chapitre sur l'impact de l'intérêt limité sur la décision d'adopter un CAE.

Dans l'examen des modèles utilisés pour prédire le comportement pro-environnemental (voir la section 2 de cette introduction), nous soulignons que les modèles d'Economie comportementale ont tendance à inclure les facteurs comportementaux un par un et, par conséquent, ne fournissent pas un modèle intégrateur. La TCP (Ajzen, 1991) semble être un cadre théorique pertinent pour identifier certains des principaux facteurs comportementaux impliqués dans l'adoption de CAE. Dans le chapitre 1, nous appliquons donc cette théorie à l'adoption d'un CAE de réduction des pesticides pour la gestion des mauvaises herbes dans une coopérative de vigneronns situés dans la région Languedoc Roussillon. Nous avons choisi

cette étude de cas car il s'agissait d'une des seules zones dans laquelle la possibilité de signer un CAE venait d'être ouverte en 2014, lorsque nous avons lancé notre travail de terrain. Cette zone se caractérise également par des caractéristiques assez simples: un seul type de CAE a été offert et les caractéristiques du système d'exploitation viticole sont relativement homogènes. Le questionnaire TCP a été mis en œuvre avec 52 des 80 vignerons professionnels de la coopérative. Grâce à une analyse économétrique, nous identifions les principales motivations impliquées dans l'adoption d'un CAE par les agriculteurs.

### ***3.1.2 Question de recherche 2: Est-ce que les normes influencent l'adoption de CAE?***

Nous pensons que les normes ont une influence sur la décision d'adopter un CAE. On peut en effet supposer que des influences normatives s'exercent dans un domaine qui est fortement marqué par les symboles de statut (par exemple "l'agriculture de bordure de route", qui est le phénomène d'observation des pratiques des autres agriculteurs en bordure de route et la façon dont cela influence les décisions) (Burton, 2004b). En outre, les agriculteurs sont soumis à une forte pression sociale de la société dans son ensemble à adopter des pratiques agricoles plus respectueuses de l'environnement. Plusieurs normes peuvent donc être à l'œuvre dans les décisions des agriculteurs: norme descriptive, ou ce que les autres agriculteurs font, norme injonctive, ou ce que les autres «pensent qu'il faut faire» (Cialdini et al, 1990), et les normes personnelles, ce qu'un agriculteur pense qu'il devrait faire (Schwartz, 1977).

La question de l'influence des normes a des implications politiques, parce que les interventions qui tiennent compte de l'influence normative, telles que des incitations adaptées ou des nudges normatifs, pourraient être mises en œuvre. D'un point de vue théorique, les normes ont été incluses dans un certain nombre de modèles de décision (par exemple Nyborg et al., 2006; Benabou et Tirole, 2012), mais la question se pose de la nécessité d'inclure les normes dans les modèles de participation aux CAE et comment cela doit être fait. Identifier une méthode permettant de déterminer empiriquement l'influence de la norme sociale est enfin un enjeu associé à cette recherche.

Notre stratégie de recherche, présentée au chapitre 2, a été d'abord de clarifier par une revue de la littérature la nature des normes, la façon dont elles influent le comportement humain et plus particulièrement les comportements pro-environnementaux. Nous avons ensuite mis en œuvre une recherche à la fois théorique et empirique. Le travail théorique est basé sur un examen des modèles existants qui tiennent compte de la norme sociale. Nous développons ensuite un modèle nouveau basé sur Rege (2004) qui tient compte à la fois des effets des

normes sociales descriptives et injonctives dans l'adoption de CAE. Notre travail empirique est basé sur un examen des méthodes empiriques existantes pour l'évaluation de l'effet de la norme sociale: préférences déclarées et préférences révélées, y compris les méthodes expérimentales. Sur la base de cet examen, nous avons décidé de privilégier l'utilisation d'une enquête de préférences déclarées qui a permis d'estimer le rôle des normes sociales perçues. Un assez court questionnaire a été conçu de telle sorte qu'il puisse être administré par internet. Il s'agit essentiellement d'une version simplifiée du questionnaire TCP du chapitre 1 avec des questions plus approfondies sur le rôle des normes. La population cible était constituée d'agriculteurs situés dans les bassins versants prioritaires, pour leur pollution par les pesticides, dans la région Languedoc-Roussillon en France. Le questionnaire a été envoyé à 700 agriculteurs situés dans ces zones grâce à la collaboration avec les animateurs chargés de la promotion des politiques agro-environnementales. Ces agriculteurs avaient été invités à adopter des CAE afin d'améliorer la qualité de l'eau et devaient prendre leur décision de participer ou non au moment de l'enquête en 2015. Notre analyse économétrique cherche à établir si les normes, entre autres déterminants, sont des moteurs importants de l'adoption de CAE.

### **3.2 Quelle est la performance des dispositifs innovants de CAE et comment elle est affectée par les facteurs comportementaux?**

Cette deuxième question, abordée dans la deuxième partie de la thèse, traite de 1) l'analyse de la performance des dispositifs innovants qui sont développés soit pour relever les défis actuels des CAE ou pour répondre à de nouveaux objectifs des politiques et 2) l'identification des facteurs comportementaux qui peuvent expliquer la performance de ces dispositifs innovants.

Nous analysons en particulier deux dispositifs innovants: un CAE dont le paiement est conditionné à la participation collective et un CAE appliqué à la mise en œuvre de la compensation écologique.

#### ***3.2.1 Question de recherche 3: Est-ce que l'introduction d'une condition de participation collective améliore l'efficacité et l'efficience des contrats CAE en présence d'un seuil environnemental?***

Ce dispositif innovant répond au problème du manque de coordination des agriculteurs dans un contexte de seuil environnemental (section 1.2.3 de cette introduction). Le principe de ce contrat est que les paiements sont conditionnés à la réalisation collective de l'effort nécessaire

pour atteindre le seuil environnemental. Nous appelons cela un CAE avec conditionnalité collective. En effet, les CAE traditionnels, qui sont basés sur les moyens, ne tiennent pas compte des seuils environnementaux et présentent un risque pour les pouvoirs publics de dépenser des fonds publics sans aucun résultat final. Afin de veiller à ce que les résultats environnementaux soient atteints au niveau individuel, plusieurs auteurs ont proposé l'utilisation de CAE orientés vers les résultats. Ces contrats considèrent cependant que les résultats environnementaux sont atteints au niveau de l'exploitation agricole individuelle, mais dans le cas de seuil environnementaux, l'obtention d'un résultat tangible sur l'environnement nécessite généralement une coordination des efforts des agriculteurs.

Notre hypothèse est que les CAE avec conditionnalité collective améliorent l'efficacité de la dépense publique en évitant le paiement des subventions aux agriculteurs dans les situations où le bien public n'est pas produit. L'efficacité de ce mécanisme peut cependant être affecté par deux dimensions comportementales: l'aversion au risque et les croyances sur la contribution des autres, une sorte de norme descriptive. Le risque de ne pas recevoir une subvention (si le seuil n'est pas atteint) est augmenté, mais les croyances sur la contribution de l'autre, peuvent également devenir plus positives et modifier la perception de la norme descriptive. Nous émettons l'hypothèse que l'influence des croyances est plus forte que l'impact de l'aversion au risque et que l'efficacité, en termes de participation aux CAE, sera améliorée.

Nous avons testé cette nouvelle forme de contrat en utilisant une expérience de laboratoire décontextualisée. Ce choix a été fait pour plusieurs raisons. Tout d'abord, cette forme de contrat est très nouvelle et pouvait difficilement être testée en tant que tel, de façon pilote, sur le terrain. Deuxièmement, cette forme de contrat aurait pu être testée en utilisant des méthodologies de préférence déclarées mais cette méthode aurait été confrontée aux limites classiques du biais hypothétique. Enfin, nous avons voulu éliciter l'aversion au risque et les croyances sur la contribution des autres, ce qui nous permettra d'expliquer la performance de cette forme de CAE. Au laboratoire, ce mécanisme a été transcrit en une subvention proportionnelle aux contributions à un bien public avec effet de seuil dont le paiement est conditionnel à l'atteinte du seuil. Le chapitre 3 présente les résultats de ce travail expérimental, réalisé avec une population de 220 étudiants. Les programmes de CAE existants qui ont des similitudes avec les CAE avec conditionnalité collective sont d'abord présentés. L'analyse des résultats expérimentaux se concentre d'abord sur l'efficacité et

l'efficacité de ce dispositif innovant et, par la suite, sur l'impact des facteurs comportementaux sous-jacents sur sa performance.

### ***3.2.2 Question de recherche 4: Les CAE sont-ils performants pour atteindre les objectifs de compensation écologique?***

La compensation écologique est de plus en plus utilisée dans les politiques environnementales afin de stopper la perte de biodiversité causée par le développement des infrastructures et l'urbanisation. Le principe de la compensation écologique est de parvenir à une «absence de perte nette» de biodiversité en contrebalançant les pertes résiduelles résultant d'un projet de développement à un endroit avec des gains prévus ailleurs. Les gains écologiques pour les compensations ont jusqu'ici principalement été obtenus grâce à des activités de restauration menées sur les terres agricoles acquises par les développeurs. Cette approche fait cependant face à des difficultés croissantes en raison de la faible disponibilité des terres et de conflits sociaux avec les agriculteurs.

L'utilisation d'un CAE, que nous appelons Contrat Agro-Environnemental de Compensation Ecologique (CAECE) est une approche émergente pour contourner cette difficulté. En effet, par rapport à l'acquisition de terrains, les CAECE peuvent être plus facilement acceptés par la communauté agricole. Cependant, l'acquisition de terres permet un contrôle à long terme de l'utilisation des terres et des pratiques agricoles alors que l'utilisation de CAECE ne fournit pas le même niveau de contrôle. Comprendre si les CAECE sont adaptés pour atteindre les objectifs d'«absence de perte nette» de biodiversité est fondamental pour déterminer si ce mécanisme représente une opportunité de surmonter la difficulté actuelle de la mise en œuvre des politiques de compensation écologique. Dans le chapitre 4, nous avons donc analysé les performances de cette nouvelle application des CAE.

Deux conditions doivent être remplies pour que les CAECE atteignent l'objectif escompté. Le premier est l'acceptabilité par les agriculteurs des CAECE proposés par les développeurs. Le second est l'efficacité des CAECE. Ce système doit en effet induire les changements réels de pratiques ou d'usage des sols nécessaires à l'obtention des gains écologiques prévus pour obtenir une absence de perte nette de biodiversité et ces changements doivent être maintenus dans le temps. Nous supposons que la flexibilité des CAECE, par rapport aux CAE traditionnels, facilite la participation des agriculteurs et que la première condition pourrait être remplie. Nous soutenons cependant que les problèmes d'efficacité liés aux CAECE (voir section 1.2) peuvent mettre en péril la réalisation des objectifs «d'absence de perte nette».

La stratégie de recherche que nous avons choisi pour aborder cette question a été de saisir l'opportunité de l'existence d'un vaste programme de CAECE (de 1000ha) mis en œuvre dans le Sud de la France et de l'analyser empiriquement. Nous avons effectué une enquête auprès des agriculteurs à qui avaient été proposés ces contrats (1169 agriculteurs) afin d'identifier les déterminants de la participation à cette nouvelle forme de CAE. Les déterminants comprenaient des facteurs à la fois traditionnels et comportementaux, tels que les normes sociales. L'efficacité des CAECE a également été analysée par le biais d'un questionnaire spécifique envoyé aux agriculteurs ayant adopté des contrats (40 répondants) qui fournit des informations qualitatives sur l'efficacité et l'efficacité des CAECE. Enfin, nous avons analysé le processus de sélection des parcelles, utilisé dans la mise en œuvre des CAECE, et ses implications sur l'efficacité et l'efficacité du programme.

### ***3.2.3 Question de recherche 5: Est-ce que la formulation du contrat a un impact sur l'adoption de CAE?***

Les objectifs finaux des CAE peuvent être formulés de différentes manières quand ils sont présentés aux agriculteurs. Notre hypothèse est que la façon dont les CAE sont présentés, et en particulier la manière dont l'objectif final du contrat est présenté peut avoir une influence sur la volonté des agriculteurs de participer. Ce phénomène est dû à l'influence de facteurs comportementaux. Cette question est importante dans la mesure où la présentation des CAE par les animateurs des programmes et l'administration pourrait en être modifiée pour améliorer la participation. Un exemple d'effet de cette formulation est la différence entre les CAECE, qui visent à ramener la qualité de l'environnement à son niveau initial après avoir été endommagé par l'intervention humaine, et les CAE de préservation de la biodiversité, qui contribuent à une augmentation de la qualité environnementale. Dans le chapitre 5, nous étudions si cette différence affecte la participation des agriculteurs.

Nous avons d'abord identifié à travers une revue de la littérature, les facteurs comportementaux qui peuvent expliquer que cette différence de formulation pourrait influencer les préférences. Nous avons ensuite décidé de quantifier ces préférences grâce à l'utilisation d'une expérience de choix (EC). Dans les EC, le choix des personnes interrogées parmi un ensemble prédéterminé de contrats hypothétiques, qui diffèrent sur des attributs spécifiques, permet de révéler les préférences pour ces attributs. Dans notre EC, les contrats hypothétiques diffèrent sur trois attributs: 1) l'objectif du contrat (compensation des pertes de biodiversité ou conservation de la biodiversité) et l'identité de l'organisation qui contractualise

(public ou privé), 2) l'existence (ou non) d'un seuil collectif de participation pour l'activation du programme et 3) le niveau de paiement. Cette EC a été mise en œuvre avec la même population utilisée dans l'enquête décrite au chapitre 4 (1169 agriculteurs à qui on a initialement offert de participer à un CAECE en 2011). L'analyse des résultats vise particulièrement à quantifier les préférences en fonction de l'objectif du contrat, et à identifier les raisons qui peuvent expliquer l'hétérogénéité des préférences.

## Résumé du chapitre 1

**Le chapitre 1** est consacré à un travail exploratoire sur les motivations qui déterminent l'adoption de CAE. Nous appliquons la théorie du comportement planifié (TCP) (Ajzen, 1991). Cette théorie est utilisée sur le cas d'une coopérative de viticulteurs dans lequel un CAE pour la réduction de l'utilisation de d'herbicides est proposé. Nous utilisons une version enrichie de la TCP qui inclut les facteurs prédictifs de comportement - l'attitude, le contrôle perçu et la norme subjective (ou la norme injonctive) - et d'autres variables considérées comme ayant une importance dans les comportements pro-environnementaux: les normes descriptives, les normes personnelles, le comportement passé et l'efficacité perçue de l'action. Nous complétons cette analyse avec une élicitation des croyances qui sont considérées comme précurseur de l'attitude, du contrôle perçu et de la norme subjective.

51 entretiens en face-à-face ont été réalisés avec des agriculteurs. Les données sont analysées à l'aide de régressions multivariée et logistique. Comme prévu, l'analyse révèle que les agriculteurs sont influencés par les motivations économiques traditionnelles: le contrôle perçu et la perception des coûts par rapport au paiement proposé. Nous soulignons également quelques-unes des contraintes et des résultats négatifs qui influencent l'adoption: le manque de flexibilité technique pour le contrôle des mauvaises herbes dans les CAE, le sentiment de perte d'autonomie, la perception d'être soumis à des contraintes financières et le manque d'information sur les contrats.

Fait intéressant, l'analyse révèle également que les agriculteurs sont influencés par deux facteurs comportementaux: la norme personnelle et la norme subjective (injonctive). Les agriculteurs qui croient que les personnes importantes pour eux sont en faveur de leur adoption du CAE sont plus susceptibles d'adopter. Les personnes qui ont l'opinion la plus influente chez les agriculteurs sont les conjoints et les techniciens de la coopérative. Nous nous attendions à ce que les agriculteurs soient influencés par la décision des autres agriculteurs et leur opinion sur les CAE. Cette analyse révèle que ce n'est que partiellement le cas. Seuls les agriculteurs référents/leaders sont perçus comme influents. Les agriculteurs voisins semblent avoir peu ou pas d'influence sur les décisions des agriculteurs individuels.

## Résumé du chapitre 2

L'enquête TCP ayant mis en évidence le rôle des normes, **le chapitre 2** met l'accent sur une meilleure compréhension du rôle des normes sociales dans l'adoption des CAE. Dans ce chapitre, nous examinons d'abord les contributions académiques sur la définition des normes sociales. Nous mettons d'abord en évidence la différence entre la norme descriptive, ou ce que les autres font, la norme injonctive, ou ce que les autres pensent qu'il faut faire (Cialdini et al., 1990), et les normes personnelles, ce qu'un individu pense qu'il devrait faire. Enfin, Bicchieri (2006) propose une définition plus complexe: les normes sociales existent, à condition que (a) les gens croient que les autres la suivent et (b) les gens croient que, à leur tour, les autres s'attendent ce que l'on suive la norme. Nous insistons sur deux aspects des normes sociales qui ressortent de ces définitions: i) le fait que les normes sont basées sur une perception individuelle et subjective de l'opinion et de la décision des autres, qui peut dans les faits faire l'objet d'une perception erronée, et ii) le fait que les normes doivent être saillantes afin d'avoir un effet.

Après un examen des modèles économiques existants tenant compte du rôle des normes sociales, nous développons un modèle basé sur le travail de Rege (2004) dans lequel nous analysons les effets des normes injonctives et descriptives sur la participation à un CAE. Nous soulignons que l'effet combiné de ces normes peut conduire à un équilibre stable dans lequel la participation reste faible. Cette prédiction du modèle peut illustrer ainsi la situation des territoires où l'adoption de CAE reste bloquée à de faibles niveaux.

Nous effectuons également une enquête en ligne pour confirmer les résultats de la TCP avec un échantillon plus large et pour illustrer les résultats de notre modèle. 98 agriculteurs éligibles aux CAE pour la réduction de l'utilisation de pesticides de la région Languedoc Roussillon ont répondu à l'enquête. L'analyse montre que trois variables sont fortement et constamment impliqués dans la décision d'adopter: la difficulté perçue liée à l'adoption, la norme injonctives et la norme personnelle. Encore une fois, comme dans la TCP le rôle de la norme descriptive et l'opinion des autres agriculteurs ne semble pas être un facteur clé dans les décisions individuelles d'adopter un CAE. Si nous analysons nos données relativement aux résultats du modèle, nous pourrions être dans une situation où la norme injonctive, ainsi que les incitations financières, sont le moteur de l'adoption de pratiques favorables à l'environnement par les agriculteurs.

Nous concluons ce chapitre en proposant un certain nombre de recommandations politiques qui prennent en compte le rôle des normes sociales et des normes personnelles. Trois options politiques possibles sont envisagées.

## Résumé du chapitre 3

Dans le **chapitre 3**, nous testons un CAE dans lequel le paiement est conditionné à un certain niveau de participation collective. Les CAE traditionnels sont individuels, basés sur les moyens et volontaires. Ils ont eu jusqu'à présent des résultats environnementaux décevants malgré les montants importants consacrés à leur mise en œuvre. Une des principales raisons de ce résultat insatisfaisant est l'adoption limitée et dispersée des contrats et l'existence de seuils environnementaux. Nous utilisons une expérience de bien public avec effet de seuil pour tester un CAE avec conditionnalité collective. Il s'agit d'une nouvelle forme de contrat dans lequel les agriculteurs ne sont payés que si le seuil environnemental est collectivement atteint. Ce contrat peut être considéré comme un contrat axé sur des résultats collectifs. Il nécessite une coordination entre les membres du groupe pour atteindre le seuil et donc déclencher le paiement de la subvention. Cette forme de contrat, dorénavant appelée subvention conditionnelle, peut exploiter le rôle des normes sociales descriptives, en modifiant la perception des décisions des autres. Il est comparé au CAE traditionnel représenté par une subvention inconditionnelle des contributions individuelles au bien public. L'expérience est conduite au laboratoire avec 220 étudiants. Nos résultats expérimentaux montrent que les CAE conditionnels sont plus efficaces que les CAE traditionnels et améliorent les résultats environnementaux. Nous étudions les facteurs comportementaux qui peuvent affecter la participation à ce régime. Nous constatons que les premières étapes de la mise en œuvre de ce mécanisme sont fondamentales pour son succès. La subvention conditionnelle augmente les croyances sur la contribution des autres au cours de la première période (une sorte de norme descriptive) qui à son tour conduit à une augmentation de la contribution qui est généralement maintenue au fil du temps. L'aversion au risque peut cependant nuire à l'efficacité de ce mécanisme. En effet, les groupes qui sont composés de sujets plus averses au risque ont tendance à ne pas réussir à se coordonner au-dessus du seuil. Nous concluons que cette nouvelle forme de contrat devrait être prise en compte dans la conception de futures politiques agro-environnementales pour accroître leur efficacité. Conditionner la totalité du paiement de CAE à la participation des autres peut toutefois être difficilement acceptable par les agriculteurs. D'autres options telles que conditionner seulement une partie du paiement (un bonus conditionnel) peuvent être plus réalisables dans ce domaine.

## Résumé du chapitre 4

**Le chapitre 4** analyse les avantages et les inconvénients de la mise en œuvre des compensations écologiques par l'utilisation de CAE de compensation écologique (CAECE). Nous étudions un programme de compensation conçu et mis en œuvre dans le Sud de la France pour compenser les pertes de biodiversité résiduelles induites par la construction d'une nouvelle ligne de chemin de fer. Ce chapitre examine (1) l'acceptabilité des CAECE par les agriculteurs, et (2) l'efficacité du dispositif et de la mise en œuvre réelle des CAECE. Une enquête réalisée auprès de 145 agriculteurs révèle que les principaux déterminants de l'acceptabilité sont: i) les facteurs économiques habituels, les agriculteurs présentant les plus faibles coûts d'opportunité et ceux qui font face à des difficultés économiques, sont plus susceptibles d'adopter, et ii) les facteurs sociaux, tels que l'importance accordée à la participation des autres agriculteurs (norme descriptive) et la perception individuelle de la position politique des organisations agricoles sur les CAECE (norme injonctive). Ceci souligne à nouveau le rôle des normes sociales dans l'adoption des CAE. En terme d'efficacité, les CAECE se révèlent être efficaces pour répondre aux exigences légales imposées au développeur, mais des préoccupations sont soulevées à propos de l'additionnalité, de la durabilité des résultats à long terme, et du non-respect par les agriculteurs des exigences contractuelles. Nous soulignons en particulier des problèmes de mise en application des termes des contrats - notamment en raison de la faiblesse des sanctions et des contrôles – et de sélection des agriculteurs qui ne permettent pas de minimiser l'aléa moral et la sélection adverse qui sont intrinsèquement liés au CAE. Nous suggérons des pistes pour améliorer la mise en œuvre des compensations par le biais des CAECE: i) l'utilisation d'enchères agro-environnementale et/ou l'utilisation de contrats basés sur les résultats plutôt que les moyens et ii) la mise en œuvre d'un système de surveillance et de contrôle par l'administration qui s'assure que le développeur, à son tour, surveille et contrôle la mise en œuvre des CAECE. Dans l'ensemble, sur la base du mode de mise en œuvre actuelle, cette analyse nous amène à remettre en question la pertinence de développer l'usage des CAECE pour atteindre l'objectif d'«absence» de perte nette de biodiversité.

## Résumé du chapitre 5

Dans le **chapitre 5**, nous analysons si la formulation des CAE peut avoir un impact sur la participation des agriculteurs. Nous nous demandons notamment si les CAE de conservation de la biodiversité, qui sont présentés comme une contribution nette à la qualité de l'environnement, sont perçus différemment d'un CAE visant à restaurer la biodiversité à son niveau initial, après perturbation par l'homme, comme les CAECE. Est-ce que cette différence de formulation de l'objectif du contrat a un impact sur la volonté des agriculteurs à participer? La préférence pour un contrat de compensation par rapport à un contrat de conservation peut être influencée par différents facteurs comportementaux. Premièrement, la compensation écologique peut être considérée comme la restauration d'une perte de la biodiversité et devrait donc être préférable, en raison de l'aversion aux pertes. Deuxièmement, dans le cadre de la compensation, le développeur est clairement responsable de la dégradation de l'environnement et les agriculteurs peuvent ne pas vouloir être considérés comme complices de cette dégradation et donc préférer un contrat de conservation. Troisièmement, les agriculteurs qui sont les plus favorables aux questions environnementales peuvent préférer des contrats de conservation car ils entraînent une meilleure qualité finale de l'environnement. Enfin, il peut y avoir une différence de confiance entre les partenaires contractuels intervenant dans les CAE traditionnels (agriculteurs et l'État / Europe) et ceux intervenant dans les CAECE (agriculteurs et développeur privé)

Nous mettons en œuvre une expérience de choix (EC) avec 82 agriculteurs pour quantifier la préférence pour les deux formulations différentes des contrats. Nos résultats montrent que les agriculteurs moyens sont plus susceptibles de choisir un contrat avec un objectif de conservation qu'un contrat avec un objectif de compensation. Dans notre échantillon, les agriculteurs demandent 37 euros de plus pour accepter un contrat avec un objectif de compensation plutôt qu'un contrat avec un objectif de conservation. Nous analysons également les facteurs comportementaux pouvant avoir une influence en testant l'interaction entre la préférence observée et les indicateurs de sensibilité aux quatre facteurs possibles affectant les préférences présentées ci-dessus. Nous montrons que la sensibilité aux questions environnementales peut être le facteur explicatif de ce résultat. Les agriculteurs qui sont les plus engagés dans l'adoption de pratiques respectueuses de l'environnement (agriculteurs biologiques) sont ceux qui sont les moins enclins à participer dans un CAECE. Ce résultat invite les organismes chargés de promouvoir les CAECE à concevoir soigneusement leur

communication en direction des agriculteurs. Si les objectifs des CAECE sont présentés comme une contribution à la conservation de la biodiversité, ils peuvent en effet être plus facilement acceptés que s'ils sont présentés comme une compensation des pertes de biodiversité.

## CONCLUSION GENERALE

Cette thèse porte sur le rôle des facteurs comportementaux dans l'adoption des CAE. Elle analyse également les performances de contrats innovants et la façon dont elles sont affectées par des facteurs comportementaux. Dans cette conclusion générale, la première section présente les principaux résultats de nos recherches sur ces deux thèmes. Dans la deuxième partie, je tire quelques conclusions générales sur le rôle des approches comportementales dans les politiques agro-environnementales. Considérant que cette thèse a utilisé les méthodologies des préférences déclarées et expérimentales, la troisième section donne des éléments sur la complémentarité de ces deux approches. Enfin, la quatrième section met en évidence les limites et les prolongements possibles de ce travail de recherche.

### 1 Principaux résultats

Le rôle des forces psychologiques et sociales n'ayant pas été suffisamment pris en compte dans les politiques agro-environnementales et plus particulièrement dans les programmes de CAE, la première partie de la thèse vise à analyser le rôle des facteurs comportementaux dans la participation aux CAE. Le **chapitre 1** est consacré à un travail exploratoire sur les motivations qui déterminent l'adoption de CAE. Nous appliquons la théorie du comportement planifié (TCP) (Ajzen, 1991). Cette théorie est utilisée sur le cas d'une coopérative de viticulteurs dans lequel un CAE pour la réduction de l'utilisation de d'herbicides est proposé. Nous utilisons une version enrichie de la TCP qui inclut les facteurs prédictifs de comportement - l'attitude, le contrôle perçu et la norme subjective (ou la norme injonctive) - et d'autres variables considérées comme ayant une importance dans les comportements pro-environnementaux: les normes descriptives, les normes personnelles, le comportement passé et l'efficacité perçue de l'action. Nous complétons cette analyse avec une élicitation des croyances qui sont considérées comme précurseur de l'attitude, du contrôle perçu et de la norme subjective.

51 entretiens en face-à-face ont été réalisés avec des agriculteurs. Les données sont analysées à l'aide de régressions multivariée et logistique. Comme prévu, l'analyse révèle que les agriculteurs sont influencés par les motivations économiques traditionnelles: le contrôle perçu et la perception des coûts par rapport au paiement proposé. Nous soulignons également quelques-unes des contraintes et des résultats négatifs qui influencent l'adoption: le manque

de flexibilité technique pour le contrôle des mauvaises herbes dans les CAE, le sentiment de perte d'autonomie, la perception d'être soumis à des contraintes financières et le manque d'information sur les contrats.

Fait intéressant, l'analyse révèle également que les agriculteurs sont influencés par deux facteurs comportementaux: la norme personnelle et la norme subjective (injonctive). Les agriculteurs qui croient que les personnes importantes pour eux sont en faveur de leur adoption du CAE sont plus susceptibles d'adopter. Les personnes qui ont l'opinion la plus influente chez les agriculteurs sont les conjoints et les techniciens de la coopérative. Nous nous attendions à ce que les agriculteurs soient influencés par la décision des autres agriculteurs et leur opinion sur les CAE. Cette analyse révèle que ce n'est que partiellement le cas. Seuls les agriculteurs référents/leaders sont perçus comme influents. Les agriculteurs voisins semblent avoir peu ou pas d'influence sur les décisions des agriculteurs individuels.

L'enquête TCP ayant mis en évidence le rôle des normes, **le chapitre 2** met l'accent sur une meilleure compréhension du rôle des normes sociales dans l'adoption des CAE. Dans ce chapitre, nous examinons d'abord les contributions académiques sur la définition des normes sociales. Nous mettons d'abord en évidence la différence entre la norme descriptive, ou ce que les autres font, la norme injonctive, ou ce que les autres pensent qu'il faut faire (Cialdini et al., 1990), et les normes personnelles, ce qu'un individu pense qu'il devrait faire. Enfin, Bicchieri (2006) propose une définition plus complexe: les normes sociales existent, à condition que (a) les gens croient que les autres la suivent et (b) les gens croient que, à leur tour, les autres s'attendent ce que l'on suive la norme. Nous insistons sur deux aspects des normes sociales qui ressortent de ces définitions: i) le fait que les normes sont basées sur une perception individuelle et subjective de l'opinion et de la décision des autres, qui peut dans les faits faire l'objet d'une perception erronée, et ii) le fait que les normes doivent être saillantes afin d'avoir un effet.

Après un examen des modèles économiques existants tenant compte du rôle des normes sociales, nous développons un modèle basé sur le travail de Rege (2004) dans lequel nous analysons les effets des normes injonctives et descriptives sur la participation à un CAE. Nous modélisons l'influence des normes sociales en se fondant sur deux hypothèses spécifiques au contexte des CAE. Tout d'abord, nous considérons que les agriculteurs peuvent être influencés par l'effet de la norme descriptive dans deux directions opposées. Lorsque le taux d'adoption est faible, les agriculteurs qui décident de ne pas adopter ressentent un sentiment

d'approbation (ils sont en conformité avec la norme descriptive) et ceux qui décident d'adopter se sentent désapprouvés. Nous pensons que, bien que l'adoption d'un CAE soit une activité pro-sociale, la norme descriptive peut en fait être anti-sociale lorsque trop peu d'agriculteurs adoptent. L'exact opposé se produit lorsqu'un nombre suffisant d'agriculteurs adopte, les agriculteurs qui n'adoptent pas se sentent désapprouver tandis que les agriculteurs qui adoptent se sentent approuvés. En résumé, la norme descriptive tend à inciter les individus à faire ce que la majorité des gens font déjà mais ne peut pas impulser un changement de comportement. La deuxième hypothèse est que la norme injonctive n'est pas exercée uniquement par les agriculteurs, mais par tous les membres de la société. Dans notre modèle, nous considérons que la norme injonctive est déterminée par le l'état de l'environnement. Lorsqu'il est dégradé, la norme injonctive en faveur d'un changement des pratiques agricoles est forte. L'influence de cette norme injonctive diminue lorsque la qualité de l'environnement s'améliore (directement liée dans notre modèle au niveau de participation dans le CAE). Par conséquent, les agriculteurs se sentent approuvés lorsqu'ils adoptent et désapprouvés lorsqu'ils ne le font pas, mais l'ampleur de ces deux effets diminue lorsque l'adoption de CAE se généralise. Nous soulignons que l'effet combiné de ces normes peut conduire à un équilibre stable dans lequel la participation reste faible. Cette prédiction du modèle peut illustrer ainsi la situation des territoires où l'adoption de CAE reste bloquée à de faibles niveaux.

Nous effectuons également une enquête en ligne pour confirmer les résultats de la TCP avec un échantillon plus large et pour illustrer les résultats de notre modèle. 98 agriculteurs éligibles aux CAE pour la réduction de l'utilisation de pesticides de la région Languedoc Roussillon ont répondu à l'enquête. L'analyse montre que trois variables sont fortement et constamment impliqués dans la décision d'adopter: la difficulté perçue liée à l'adoption, la norme injonctives et la norme personnelle. Encore une fois, comme dans la TCP le rôle de la norme descriptive et l'opinion des autres agriculteurs ne semble pas être un facteur clé dans les décisions individuelles d'adopter un CAE. Si nous analysons nos données relativement aux résultats du modèle, nous pourrions être dans une situation où la norme injonctive, ainsi que les incitations financières, sont le moteur de l'adoption de pratiques favorables à l'environnement par les agriculteurs.

Nous concluons ce chapitre en proposant un certain nombre de recommandations politiques qui prennent en compte le rôle des normes sociales et des normes personnelles. Trois options politiques possibles sont envisagées.

Tout d'abord, le renforcement de la saillance de la norme descriptive ( $\lambda$  dans notre modèle) pourrait être une option compte tenu de son faible effet actuel, mais nous soulignons que cela pourrait dans les faits être contre-productif. En effet, la norme descriptive a tendance à limiter l'adoption lorsque la participation est faible.

Deuxièmement, comme la norme injonctive semble avoir un effet significatif sur l'adoption, des campagnes de communication insistant sur cette norme pourrait être pertinentes. Le chapitre 1 montre que les agriculteurs se soucient particulièrement de l'opinion des techniciens référents, des agriculteurs référents et des conjoints. Nous recommandons donc le ciblage de ces populations pour augmenter la pression sociale et indirectement inciter les agriculteurs à modifier leurs pratiques agricoles. Le ministère français de l'Agriculture a développé un réseau de 1900 fermes référentes, les fermes Dephy, pour démontrer que l'agriculture avec une faible utilisation de pesticides est techniquement possible. Nous soutenons que les agriculteurs qui sont considérés comme référent par d'autres agriculteurs pourraient être la cible prioritaire dans ces réseaux afin de maximiser l'effet sur d'autres agriculteurs. La communication pourrait également être destinée à un public plus large. Par exemple, pour les questions de qualité de l'eau, les collectivités locales et les agences de l'eau devraient développer la communication sur les données de qualité de l'eau aux communautés locales en général, plutôt que de cibler seulement les agriculteurs. La directive européenne 2003/4/CE sur l'accès à l'information environnementale donne un cadre juridique pour ce type d'initiative.

Troisièmement, nous proposons d'avoir recours à des interventions qui modifieraient les croyances sur la participation des autres agriculteurs dans les CAE (modifier la perception de  $x$  dans notre modèle). Ceci peut être réalisé à travers le développement de dispositifs innovants dont le paiement est conditionné à un seuil minimum de participation des agriculteurs, comme le bonus collectif étudié dans Kuhfuss et al. (2014) ou le CAE avec conditionnalité collective que nous étudions au chapitre 3.

**Dans la partie 2**, nous analysons les performances de dispositifs innovants de CAE et comment ces performances peuvent être affectées par des facteurs comportementaux. Dans le **chapitre 3**, nous testons un CAE dans lequel le paiement est conditionné à un certain niveau de participation collective. Les CAE traditionnels sont individuels, basés sur les moyens et volontaires. Ils ont eu jusqu'à présent des résultats environnementaux décevants malgré les montants importants consacrés à leur mise en œuvre. Une des principales raisons de ce

résultat insatisfaisant est l'adoption limitée et dispersée des contrats et l'existence de seuils environnementaux. Nous utilisons une expérience de bien public avec effet de seuil pour tester un CAE avec conditionnalité collective. Il s'agit d'une nouvelle forme de contrat dans lequel les agriculteurs ne sont payés que si le seuil environnemental est collectivement atteint. Ce contrat peut être considéré comme un contrat axé sur des résultats collectifs. Il nécessite une coordination entre les membres du groupe pour atteindre le seuil et donc déclencher le paiement de la subvention. Cette forme de contrat, dorénavant appelée subvention conditionnelle, peut exploiter le rôle des normes sociales descriptives, en modifiant la perception des décisions des autres. Il est comparé au CAE traditionnel représenté par une subvention inconditionnelle des contributions individuelles au bien public. L'expérience est conduite au laboratoire avec 220 étudiants. Nos résultats expérimentaux montrent que les CAE conditionnels sont plus efficaces que les CAE traditionnels et améliorent les résultats environnementaux. Nous étudions les facteurs comportementaux qui peuvent affecter la participation à ce régime. Nous constatons que les premières étapes de la mise en œuvre de ce mécanisme sont fondamentales pour son succès. La subvention conditionnelle augmente les croyances sur la contribution des autres au cours de la première période (une sorte de norme descriptive) qui à son tour conduit à une augmentation de la contribution qui est généralement maintenue au fil du temps. L'aversion au risque peut cependant nuire à l'efficacité de ce mécanisme. En effet, les groupes qui sont composés de sujets plus averses au risque ont tendance à ne pas réussir à se coordonner au-dessus du seuil. Nous concluons que cette nouvelle forme de contrat devrait être prise en compte dans la conception de futures politiques agro-environnementales pour accroître leur efficacité. Conditionner la totalité du paiement de CAE à la participation des autres peut toutefois être difficilement acceptable par les agriculteurs. D'autres options telles que conditionner seulement une partie du paiement (un bonus conditionnel) peuvent être plus réalisables dans ce domaine.

Les chapitre 4 et 5 portent sur une nouvelle application des CAE à la compensation écologique. Les politiques environnementales s'intéressent de plus en plus à la compensation écologique comme un moyen de ralentir ou d'arrêter la perte de biodiversité causée par les projets de développement d'infrastructures et l'urbanisation. **Le chapitre 4** analyse les avantages et les inconvénients de la mise en œuvre des compensations écologiques par l'utilisation de CAE de compensation écologique (CAECE). Nous étudions un programme de compensation conçu et mis en œuvre dans le Sud de la France pour compenser les pertes de biodiversité résiduelles induites par la construction d'une nouvelle ligne de chemin de fer. Ce

chapitre examine (1) l'acceptabilité des CAECE par les agriculteurs, et (2) l'efficacité du dispositif et de la mise en œuvre réelle des CAECE. Une enquête réalisée auprès de 145 agriculteurs révèle que les principaux déterminants de l'acceptabilité sont: i) les facteurs économiques habituels, les agriculteurs présentant les plus faibles coûts d'opportunité et ceux qui font face à des difficultés économiques, sont plus susceptibles d'adopter, et ii) les facteurs sociaux, tels que l'importance accordée à la participation des autres agriculteurs (norme descriptive) et la perception individuelle de la position politique des organisations agricoles sur les CAECE (norme injonctive). Ceci souligne à nouveau le rôle des normes sociales dans l'adoption des CAE. En terme d'efficacité, les CAECE se révèlent être efficaces pour répondre aux exigences légales imposées au développeur, mais des préoccupations sont soulevées à propos de l'additionnalité, de la durabilité des résultats à long terme, et du non-respect par les agriculteurs des exigences contractuelles. Nous soulignons en particulier des problèmes de mise en application des termes des contrats - notamment en raison de la faiblesse des sanctions et des contrôles – et de sélection des agriculteurs qui ne permettent pas de minimiser l'aléa moral et la sélection adverse qui sont intrinsèquement liés au CAE. Nous suggérons des pistes pour améliorer la mise en œuvre des compensations par le biais des CAECE: i) l'utilisation d'enchères agro-environnementale et/ou l'utilisation de contrats basés sur les résultats plutôt que les moyens et ii) la mise en œuvre d'un système de surveillance et de contrôle par l'administration qui s'assure que le développeur, à son tour, surveille et contrôle la mise en œuvre des CAECE. Dans l'ensemble, sur la base du mode de mise en œuvre actuelle, cette analyse nous amène à remettre en question la pertinence de développer l'usage des CAECE pour atteindre l'objectif d'«absence» de perte nette de biodiversité.

Dans le **chapitre 5**, nous analysons si la formulation des CAE peut avoir un impact sur la participation des agriculteurs. Nous nous demandons notamment si les CAE de conservation de la biodiversité, qui sont présentés comme une contribution nette à la qualité de l'environnement, sont perçus différemment d'un CAE visant à restaurer la biodiversité à son niveau initial, après perturbation par l'homme, comme les CAECE. Est-ce que cette différence de formulation de l'objectif du contrat a un impact sur la volonté des agriculteurs à participer? La préférence pour un contrat de compensation par rapport à un contrat de conservation peut être influencée par différents facteurs comportementaux. Premièrement, la compensation écologique peut être considérée comme la restauration d'une perte de la biodiversité et devrait donc être préférable, en raison de l'aversion aux pertes. Deuxièmement, dans le cadre de la compensation, le développeur est clairement responsable de la dégradation

de l'environnement et les agriculteurs peuvent ne pas vouloir être considérés comme complices de cette dégradation et donc préférer un contrat de conservation. Troisièmement, les agriculteurs qui sont les plus favorables aux questions environnementales peuvent préférer des contrats de conservation car ils entraînent une meilleure qualité finale de l'environnement. Enfin, il peut y avoir une différence de confiance entre les partenaires contractuels intervenant dans les CAE traditionnels (agriculteurs et l'État / Europe) et ceux intervenant dans les CAECE (agriculteurs et développeur privé)

Nous mettons en œuvre une expérience de choix (EC) avec 82 agriculteurs pour quantifier la préférence pour les deux formulations différentes des contrats. Nos résultats montrent que les agriculteurs moyens sont plus susceptibles de choisir un contrat avec un objectif de conservation qu'un contrat avec un objectif de compensation. Dans notre échantillon, les agriculteurs demandent 37 euros de plus pour accepter un contrat avec un objectif de compensation plutôt qu'un contrat avec un objectif de conservation. Nous analysons également les facteurs comportementaux pouvant avoir une influence en testant l'interaction entre la préférence observée et les indicateurs de sensibilité aux quatre facteurs possibles affectant les préférences présentées ci-dessus. Nous montrons que la sensibilité aux questions environnementales peut être le facteur explicatif de ce résultat. Les agriculteurs qui sont les plus engagés dans l'adoption de pratiques respectueuses de l'environnement (agriculteurs biologiques) sont ceux qui sont les moins enclins à participer dans un CAECE. Ce résultat invite les organismes chargés de promouvoir les CAECE à concevoir soigneusement leur communication en direction des agriculteurs. Si les objectifs des CAECE sont présentés comme une contribution à la conservation de la biodiversité, ils peuvent en effet être plus facilement acceptés que s'ils sont présentés comme une compensation des pertes de biodiversité.

## **2 Les approches comportementales dans les politiques agro-environnementales**

Cette thèse met l'accent sur le rôle des facteurs comportementaux, tels que les normes sociales, les normes personnelles et la formulation de l'objectif, ainsi que des motivations économiques traditionnelles dans la décision des agriculteurs de participer à un CAE. Ces facteurs comportementaux interviennent dans les CAE traditionnels ainsi que les dispositifs contractuels innovants: CAE avec conditionnalité collective ou CAECE. Les facteurs

comportementaux peuvent soit contribuer à l'efficacité des CAE ou au contraire limiter cette efficacité.

L'importance de ces facteurs n'a pas encore été suffisamment prise en compte en Europe, sauf au Royaume-Uni. Il est donc nécessaire de renforcer les approches comportementales dans la conception et la mise en œuvre des politiques agricoles. Deux utilisations directes des approches comportementales semblent être particulièrement pertinentes dans les politiques agro-environnementales:

- **Modifier les incitations afin d'exploiter l'effet des facteurs comportementaux et / ou éviter les inefficacités dues à ces facteurs comportementaux.** Un des exemples est la subvention conditionnelle proposée dans le chapitre 3, qui peut exploiter l'effet de la norme descriptive afin de provoquer une plus large participation. Dans le chapitre 5, nous mettons en évidence l'effet négatif de la formulation des CAECE, en tant que compensation de dommages écologiques, sur le consentement à recevoir des agriculteurs. Changer la façon dont les contrats sont présentés aux agriculteurs serait un moyen d'éviter cette source d'inefficacité.

- **Développer l'utilisation de nudges verts.** Bien que nous n'ayons pas testé de nudges dans cette thèse, notre constat de l'influence des normes milite pour l'utilisation possible de ce type d'instrument pour renforcer l'adoption de comportements pro-environnemental chez les agriculteurs.

À mon avis, ces deux approches doivent être considérées de façon concomitante. Dans les pays où l'économie comportementale est devenue influente, il y a une tentation de substituer les instruments de politiques traditionnels qui sont coûteux par des interventions comportementales à faible coût telles que les nudges verts. Ceci me semble être une stratégie risquée. Les agriculteurs sont influencés par une diversité de motivations, telles que les motivations intrinsèques et extrinsèques. Des approches multifactorielles sont donc nécessaires pour s'assurer que les agriculteurs adoptent des pratiques plus favorables à l'environnement: des incitations telles que les CAE, des mesures réglementaires et des interventions comportementales. La diversité des facteurs en jeu explique qu'il a été si difficile pour les décideurs politiques d'induire des changements durables. Les interventions doivent donc tenir compte de différents facteurs à la fois, et être adaptables pour différents publics et contextes (Darnton, 2008).

Nos résultats suggèrent qu'une catégorie d'agriculteurs refuse de participer à des CAE, maintenant ou dans l'avenir. Abandonner ces agriculteurs dans la mise en œuvre des politiques agro-environnementales pourrait être particulièrement problématique, car ils sont susceptibles d'être les plus importants pollueurs. Quelles politiques européennes pourraient cibler ces agriculteurs? Ils peuvent être ciblés par le «verdissement» de la PAC et par les normes minimales mentionnées dans les «bonnes conditions agro-environnementales». Ces mesures sont toutefois largement permissives et ne touchent que les agriculteurs qui reçoivent des paiements de la PAC (ce n'est pas le cas pour de nombreux agriculteurs tels que les maraîchers ou les viticulteurs). Une autre option fréquemment recommandée pour cibler ces agriculteurs est le recours à des mesures réglementaires. Cependant, cela nécessiterait une volonté politique forte compte tenu de la résistance probable des syndicats d'agriculteurs contre ces approches obligatoires. Cela n'est donc pas susceptible de se produire dans le contexte politique européen actuel. L'utilisation de nudges verts pourrait donc être un moyen novateur et politiquement acceptable pour faciliter l'adoption de pratiques favorables à l'environnement par ces agriculteurs «réticents».

Quelques précautions sont néanmoins nécessaires dans la façon dont les nudges seraient utilisés. Cet instrument de politique peut en effet générer un sentiment de perte d'autonomie et de manipulation qui pourrait compromettre son effet (Schubert, 2016). Cela pourrait être une question particulièrement sensible dans le monde agricole, car il y a parfois des soupçons sur la bonne intention des autorités gouvernementales. Cela exige donc une certaine transparence sur la présentation de ces mesures. Il y a cependant un compromis à trouver dans le niveau de transparence, car révéler toutes les informations peut effectivement compromettre les effets des nudges, qui reposent en quelque sorte sur le fait que les gens sont influencés sans le remarquer.

L'utilisation d'approches comportementales pourrait être plus largement incluse dans les principales étapes du cycle de conception et de mise en œuvre de la politique agricole présentées dans Collier et al (2010):

- **Comprendre la situation.** Les approches comportementales peuvent aider à comprendre les motivations sous-jacentes des agriculteurs à adopter ou non des pratiques favorables à l'environnement. Cela peut aider à identifier des interventions politiques adéquates. La partie 1 de la thèse montre par exemple le rôle joué par les normes injonctives et personnelles dans le choix des agriculteurs d'adopter un CAE.

- **Développer et évaluer les options.** La modélisation économique est une méthode utile pour évaluer ex-ante la performance des politiques agricoles. L'intégration de facteurs comportementaux dans ces modèles économiques serait importantes pour obtenir de meilleures prévisions de la performance des interventions politiques, tels que les CAE. Une utilisation plus large de l'économie expérimentale, l'un des principaux outils de l'économie comportementale, serait également particulièrement pertinente pour tester de nouveaux instruments de politique et pour établir comment leur performance peut être affectée par des facteurs comportementaux (Colen et al., 2016). Dans les chapitres 3 et 5, nous présentons le test de dispositifs innovants de CAE avec une expérience de laboratoire et une expérience de choix.

- **Préparation la mise en œuvre.** Les approches comportementales peuvent fournir des informations sur une utilisation appropriée des campagnes de communication qui pourrait améliorer les résultats des politiques. Il est essentiel de reconnaître l'importance des facteurs sociaux (tels que les normes sociales) à cette étape. Cela implique par exemple de faire en sorte que des intermédiaires de confiance soient mobilisés pour la mise en œuvre des politiques.

- **Contrôle et évaluation.** Traditionnellement, le suivi et la mise en œuvre ne se soucient que de l'impact des politiques sur les décisions des agriculteurs, principalement en matière de pratiques agricoles. Les approches comportementales militent pour le suivi de l'impact des politiques non seulement sur le comportement, mais aussi sur les motivations sous-jacentes des agriculteurs.

Ce développement d'approches comportementales dans l'UE nécessiterait la mise en œuvre d'un programme de renforcement des capacités. Cela a été initié dans le passé récent par la création d'équipes d'experts tels que l'équipe « Behavioral Insights » au Royaume-Uni. En Europe, cela pourrait être fait en mobilisant les initiatives en cours, telles que le EU policy lab, sur les questions agricoles. Au niveau français, le recrutement d'experts en Economie comportementale et Psychologie sociale, pour conseiller le gouvernement, y compris le ministère de l'agriculture serait une première étape. Au niveau plus local, le recrutement récent d'une économiste comportementale à l'Etablissement Public Loire, institut chargé de la gestion de l'eau dans le bassin de la Loire en France, est un exemple qui pourrait être reproduit. Enfin, il serait intéressant de développer des programmes de renforcement des capacités sur les approches comportementales pour les professionnels qui sont en contact

direct avec les agriculteurs sur les questions de pratique agricole. Par exemple, en France, certains bassins versants ont été considérés comme prioritaires en raison de problèmes de qualité de l'eau potable. Des animateurs ont été recrutés pour stimuler les initiatives locales sur la qualité de l'eau. Ces animateurs qui interagissent quotidiennement avec les agriculteurs pourraient être formés sur l'utilisation de ces approches.

### **3 Utilisation des méthodes de préférences déclarées et des méthodologies expérimentales**

Dans cette thèse, nous avons mobilisé des méthodes de préférences déclarées et expérimentales, mais les méthodes de préférences déclarées dominent. L'utilisation de ces méthodes nous a semblé fondamentale dans cette phase exploratoire du rôle des facteurs comportementaux dans l'adoption de CAE (partie 1). D'autres travaux nécessiteront l'utilisation de méthodes expérimentales afin, par exemple, d'établir plus fermement le rôle des normes injonctives et personnelles dans l'adoption de CAE. Manipuler ces facteurs pour déterminer expérimentalement leurs effets sur un résultat comme l'adoption d'un CAE ne semble toutefois pas simple. Nous avons également constaté l'absence d'effet de la décision d'autres agriculteurs sur les décisions individuelles. D'autres études semblent toutefois révéler le contraire (par exemple Chen et al, 2009; Kuhfuss et al 2016). Il faut souligner que les individus sont généralement réticents à admettre que leurs décisions peuvent être influencées par une comparaison consciente (ou non-consciente) avec ce que d'autres choisissent de le faire. Nos résultats, qui sont basés sur des déclarations, peuvent être affectés par un biais de déclaration. Nous devons donc améliorer la qualité de l'enquête sur ce point ou utiliser des méthodes expérimentales pour confirmer ou infirmer ce résultat.

Notre approche illustre un possible schéma de programme de recherche qui vise à 1) l'identification des facteurs comportementaux impliqués dans les décisions des agriculteurs et ii) l'identification des mesures politiques pertinentes. Les méthodes de préférences déclarées sont particulièrement pertinentes pour comprendre la diversité des motivations qui interviennent dans les comportements pro-environnementaux. La psychologie sociale fournit des directives normalisées pour l'identification de ces motivations au moyen de questionnaires. Ces méthodes sont cependant limitées pour établir des liens de causalité solides entre les motivations et le changement de comportement. Les méthodologies expérimentales au contraire, fournissent un meilleur cadre pour démontrer l'effet causal de

divers facteurs comportementaux sur les décisions humaines. L'inconvénient de cette méthode plus «rigoureuse» est généralement qu'il examine l'effet de ces différents facteurs un par un séparément. Les méthodes expérimentales sont par contre particulièrement pertinentes pour tester des interventions comportementales, qui peuvent jouer sur ces facteurs, et déterminer leur impact sur les décisions des agriculteurs. Cela peut se faire de manière progressive en utilisant des expériences de laboratoire, des expériences de terrain, des expériences de choix et finalement des essais contrôlés randomisés (Colen et al., 2016).

Ce schéma général peut toutefois être contesté en fonction du facteur comportemental considéré. En effet, les facteurs comportementaux qui sont regroupés sous le terme de rationalité limitée (Mullainathan et Thaler, 2000), tels que l'aversion à la perte, l'incohérence temporelle ou les effets du contexte, sont fréquemment analysés avec des expériences, mais ne peuvent pas être correctement identifiés avec des méthodologies de préférences déclarées. D'autres facteurs comportementaux, comme les normes injonctives ou les normes personnelles, sont difficiles à évaluer dans une expérience. Il est en effet compliqué d'appliquer des traitements qui modifient la perception de ces normes et d'observer l'impact sur le comportement. Ceci est particulièrement compliqué dans les expériences économiques dans lesquelles mentir aux sujets est rejeté par la communauté scientifique. Les méthodes de préférences déclarées et expérimentales semblent donc être complémentaires pour l'étude des décisions et l'identification des interventions appropriées pour déclencher un changement de comportement des agriculteurs, ainsi que dans l'étude de la diversité des facteurs comportementaux.

## **4 Limites et pistes de recherche**

La thèse présente plusieurs limites en terme de périmètre de recherche qui pourraient nécessiter des études complémentaires dans le futur. Deux pistes de recherche semblent particulièrement intéressantes.

Tout d'abord, la thèse ne tient compte que de l'importance d'un nombre limité de facteurs comportementaux, essentiellement les normes sociales, les normes personnelles et l'effet du contexte. D'autres facteurs comportementaux liés à la rationalité limitée, tels que l'aversion à la perte, l'incohérence temporelle, qui pourrait également avoir un impact sur l'adoption CAE ne sont pas pris en compte dans cette étude. D'autres facteurs, proches de la rationalité limitée, qui sont plutôt étudiés en psychologie, tels que le rôle des émotions ou le fait que les

individus utilisent plutôt des heuristiques pour prendre des décisions, ne sont également pas étudiés. Nous ne considérons pas non plus l'effet négatif potentiel des incitations monétaires (effet d'éviction) sur les motivations intrinsèques, comme les normes personnelles par exemple. Ce phénomène peut se produire en particulier dans les situations où les agriculteurs avaient déjà adopté une pratique pro-environnementale, ont ensuite reçu des incitations pendant quelques années par l'intermédiaire d'un CAE pour continuer à le faire, et cette incitation a été abandonnée. Il existe en effet un risque que les agriculteurs cessent cette activité suite à la fin de cette incitation monétaire, alors qu'ils la maintenaient sans elle.

Deuxièmement, nous avons surtout examiné le rôle des facteurs comportementaux dans l'adoption de CAE et non pas dans l'adoption de pratiques favorables à l'environnement. Ce choix a été fait car nous avons considéré que les incitations monétaires étaient nécessaires pour assurer un changement de pratique. Il serait cependant également pertinent d'étudier directement l'effet des facteurs comportementaux sur l'adoption de pratiques favorables à l'environnement en l'absence d'incitations monétaires.

Cette thèse présente enfin plusieurs limites méthodologiques et pistes de recherche possibles.

La première est que la plupart de nos études empiriques, sauf l'étude expérimentale présentent un échantillon relativement réduit. Cette limite est due à plusieurs raisons. Tout d'abord, l'analyse des problèmes de comportement nécessite la collecte de données nouvelles. En effet, les bases de données existantes ne contiennent généralement pas les informations qui peuvent être exploitées pour analyser l'impact des facteurs comportementaux. La deuxième raison est la difficulté à engager les institutions agricoles dans la participation à ces enquêtes et à partager leurs bases de données. Par conséquent, nous avons eu accès à une population relativement faible d'agriculteurs. Enfin, le taux de réponse aux enquêtes par les agriculteurs a également été faible (environ 10%). Malgré cette limite, nous avons été en mesure de tirer des résultats significatifs et robustes de nos analyses économétriques, en particulier sur le rôle des normes sociales.

Nous utilisons l'économie expérimentale au chapitre 3 pour tester un système de subventions conditionné à une participation collective. Cette expérience est toutefois seulement mise en œuvre au laboratoire avec un échantillon d'étudiants. Les résultats que nous avons obtenus doivent donc être confirmés avec une population d'agriculteurs. L'approche envisagée serait d'abord de reproduire la même expérience, avec l'approche «laboratoire sur le terrain», puis de mettre en œuvre une expérience contextualisée. Dans un premier temps, il avait également

été ambitionné de tester un dispositif innovant de CAE à travers un essai-pilote ou la mise en place d'un essai contrôlé randomisé directement sur le terrain. Une proposition de projet a été développée avec un bureau d'étude, mais le projet n'a finalement pas été financé. L'identification d'une administration locale prête à tester un CAE innovant et à financer la mise en œuvre de ce dispositif et le coût des incitations s'est avérée très compliquée. Cela n'a donc pas été possible pendant dans la durée de la thèse, mais reste toujours en discussion pour un prolongement du travail.

D'autres approches seraient également pertinentes pour analyser l'influence de la norme sociale plus en détails. Par exemple, nos résultats rejettent l'importance de l'opinion des agriculteurs voisins, mais l'avis de certains agriculteurs référents est important dans la décision des agriculteurs. Cela signifierait que convaincre ces quelques agriculteurs référents peut avoir un effet important sur le comportement de tous les agriculteurs. Pour confirmer ce résultat, il faudrait utiliser des méthodes pour identifier les réseaux sociaux et leur rôle dans l'adoption des CAE. Grâce à cette méthode, il serait possible d'identifier les agriculteurs qui ont un rôle central. Une fois identifiés, des approches expérimentales pourraient être utilisées pour comparer les différentes méthodes de vulgarisation et leur impact sur l'adoption de CAE: une approche de communication standard auprès de l'ensemble des agriculteurs et une autre qui se concentre sur les individus centraux dans le réseau, en utilisant une approche similaire à celle Banerjee et al (2013) sur la micro-finance .

Enfin, ce travail a peu analysé l'impact possible des nudges. La seule contribution est la participation au projet de recherche sur l'impact de l'information sociale sur la permanence des pratiques favorables à l'environnement après la fin des contrats AES (Kuhfuss et al., 2016). Bien que les nudges aient été largement utilisés dans les politiques environnementales en général, leur application à l'agriculture reste encore anecdotique. Cela ouvre de grandes perspectives pour la recherche future. Par exemple, compte tenu de l'effet des normes injonctives sur l'adoption de CAE, l'utilisation de nudges informationnels focalisés sur cette norme pourrait être un moteur pour renforcer l'adoption de CAE ou directement de pratiques respectueuses de l'environnement. Concevoir une expérience pour tester un tel nudge couplé avec une méthodologie rigoureuse d'analyse d'impact est une piste intéressante pour de futures recherches.



