Farmers' Preferences on Implementing Biodiversity Offsets on Arable Lands: A Choice Experiment Study

Anne-Charlotte Vaissière[1], Léa Tardieu[2], Fabien Quétier[3], Sébastien Roussel[4]

This version (April, 15 2016) is based on ongoing works. We have completed the pilot study and the final study is currently being launched. The final results will have been analyzed at the time that the conference will be held. *Please do not quote without the authors' permission*

Abstract

Biodiversity Offsetting (BO) is supposedly aimed at achieving No Net Loss (NNL) of biodiversity in the context of development. Agricultural landscapes sometimes have low levels of biodiversity, and the ecological restoration or enhancement of arable lands through BO may show ecological gains. However, farmers' implementing BO on their arable land, against payments by developers, remains a controversial topic that has been little studied and discussed in the scientific literature. One could wonder if the implementation of long term BO contracts, satisfying restrictive conditions for ecological performance, can match farmers' preferences and constraints. Our study aims at providing key factors explaining the decision by farmland owners to sign a BO contract, with those contracts satisfying the NNL imperative. In order to capture the farmers' preferences, we conducted a Choice Experiment (CE) study at the scale of a French agricultural region. Four attributes, describing different scenarios of BO measures, were selected: the management plan of the actual ecological measures for ecosystem enhancement, the length of the contract, the annual payment, and, in an innovative way, a monetary bonus for additional ecologically relevant contractual terms. Preliminary results suggest a trade-off between biodiversity conservation requirements and socio-economical stakes. Among the attributes having a significant effect on farmers' utility, the ones that better explain the willingness (or reluctance) to sign BO contracts are the length of the contract and the annual payment. Further, a spatial analysis linked to answers regarding additional ecologically relevant contractual terms through the monetary bonus, should also be conducted.

JEL classification: Q15, Q24, Q57.

Keywords: Agricultural contract, biodiversity offset, choice experiment, land management.

[1] Corresponding author: Université de Montpellier (UM), UMR 5474 Laboratoire Montpelliérain d'Économie Théorique et Appliquée (LAMETA), F-34000 Montpellier, France. Email: anne.charlotte.vaissiere@gmail.com

[2] INRA, AgroParisTech, UMR356 Laboratoire d'Économie Forestière (LEF), F-54000 Nancy, France. Email: lea.tardieu@nancy.inra.fr

[3] Biotope, F-34140 Mèze, France. Email: fquetier@biotope.fr

[4] Université Paul Valéry Montpellier 3 (UPVM3), UMR 5474 LAMETA, F-34000 Montpellier, France. Email: sebastien.roussel@lameta.univ-montp1.fr, sebastien.roussel@univ-montp3.fr

1 Introduction

Development projects, including urbanization or the construction of transport infrastructures, often leads to alter natural and semi-natural ecosystems, with consequent impacts on ecological processes and biodiversity. Even if developers must follow a mitigation hierarchy including measures to first avoid and then reduce their potential impacts on biodiversity, they often end up with significant residual impacts on ecosystems and species. Offsetting, the last step of the mitigation hierarchy, is supposed to compensate for these residual ecological losses in order to have a No Net Loss (NNL) of biodiversity once the project and its measures are carried out. Biodiversity Offsets (BO)[5] are based on ecological engineering measures that have to provide ecological gains that are equivalent to the ecological losses in the impacted area. They also have to be additional to other measures of biodiversity conservation (e.g., observance of eco-conditionality for Common Agricultural Policy (CAP) subsidies or contracted Agri-Environment Schemes (AES), mandatory buffer zones along watercourses and lakes pursuant to Nitrate Directive) and cannot replace previously planned and funded programs. So far, impacts on ordinary biodiversity are not considered through the avoidance and reduction steps (Tardieu et al., 2015) and the offset step (Baker et al., 2013; Burylo et al., 2013; CBD and UNEP-WCMC, 2012) of the mitigation hierarchy. Only impacts on some ecosystems, such as wetlands or protected flora and fauna, lead to BO.

In France, BO has been very poorly implemented since its very first mention in the 1976 Nature Protection Act. Over the past few years, the French Ministry of Environment, Energy and Sea published several guidelines for a better implementation of the mitigation hierarchy (MEDDE, 2013; MEDTL, 2012). However the propositions are not coercive. Nonetheless, a new project of Law on biodiversity is currently still in debate. The regulatory framework is thus not stabilized and creates a fuzzy context for BO implementation. As a consequence, BOs are increasingly carried out because of legal requirement for projects designers, but with low quality leading to social acceptance issues. This is particularly problematic for BO to be applied in agricultural lands. Farmers often report that they are suffering a double or even triple penalty on their arable lands (de Billy et al., 2015; Etrillard and Pech 2015). Objections relate principally to: (1) the use of lands for development projects; (2) the second mobilization of lands for impact compensation; and, (3) the subsequent pressure on arable land prices. The implementation of BO in arable lands is therefore controversial. Nevertheless, some farmers seem to be in favor of BO initiatives, by carrying out management plans on their lands on behalf of developers, instead of selling them their lands (Etrillard and Pech 2015).

The objective of this article is to assess farmers' preferences on implementing BO on arable lands. We aim at delineating, from an empirical study, the conditions within which it is possible to consider that farmers would accept to contract a BO or not. The main idea is to assess whether these conditions (e.g., duration, type of ecological measures) are in accordance with BO ecological requirements, and if the monetary claims seem realistic with usual budgets dedicated to mitigation measures in development projects. The results of this work have policy implications by feeding the current discussions and negotiations around on-going projects and the national agenda with the Law on biodiversity. We believe that agriculture may have a role on the compensation of development project impacts on biodiversity. However, BO measures cannot be imposed to and suffered by farmers, and they must be consistent with ecological objectives.

[5] We use BO in turns whilst referring to Biodiversity Offset(s) or Biodiversity Offsetting.

We conduct a Choice Experiment (CE), and explore a less studied feature of this now widely used approach. We use a Bayesian efficient design, based on results from a pilot study, to create choice cards in which farmers are asked to choose between two different alternative BO contracts and a status quo option where farmers keep their actual practices. BO proposals vary with different levels of contract attributes selected with focus groups: management plan of the land restoration, contract duration, and the annual payment. One of the relevant components of this work is that we address the specific issue of the integration of an additional ecologically pertinent term in the contract (connected parcels or agglomeration), constituting the last attribute. This kind of attribute can be related to the literature on network or agglomeration bonuses that are side payments offered in addition to the baseline contract payment, only paid when contiguous land is enrolled (Parkhurst and Shogren, 2007; Drechsler et al, 2010; Banerjee et al, 2012). Our approach differs in those by addressing the self-individual spatial coordination of land, and preferences of farmers for ecological efficiency. In the final paper, we aim at conducting a spatial analysis in order to assess whether the claims in land enrollment with additional ecological criteria is significantly efficient or not, and how spatial component explains enrolment. We finally calculate farmer's Willingness To Accept (WTA) for implementing different features of BO contracts and analyze how the relative levels of the attributes influence farmer's choices.

The remainder of this paper is organized as follows. In Section 2, we make a state of the art of CE regarding environmental contracts signed by farmers, and we present the methodological options for our case study. In Section 3, we present the results of our empirical work (from the pilot study in this version of the paper). In Section 4, we discuss the farmers' preferences for implementing BO on arable lands and policy implications.

2 Materials and methods

2.1 State of the art of choice experiments regarding environmental contracts signed by farmers

Since Lancaster's Consumer Theory (Lancaster, 1966) and the Random Utility Theory (Luce, 1959; McFadden, 1974), the Choice Experiment (CE) approach has been increasingly used over the past few years in various research areas (transport economics marketing, environmental economics), and in particular regarding the preferences of farmers for Agri-Environment Schemes (AES). These studies seek to understand which parameters would be considered for improving the participation in AES contracts, and to understand the stakeholder's preferences for biodiversity conservation schemes (e.g., Broch and Vedel, 2012; Lienhoop and Brouwer, 2015). Over the contract length and the extent of the subsidy that are usually tested, attributes related to the flexibility of the contracts may involve technical choices (Bougherara and Ducos, 2006; Christiensen et al., 2011; Espinosa-Goded et al., 2010; Kuhfuss et al., 2014), the parcels being involved in the contracts (Ruto and Garrod, 2009; Bougherara and Ducos, 2006), the fact that the measures, or bonuses, have a collective dimension (Chen et al., 2009; Kuhfuss et al., 2015), or the possibility to opt out of the contract before its end (Broch et al., 2013; Greiner et al., 2014). The administrative burden is also often studied (Bougherara and Ducos, 2006 ; Christensen et al., 2011; Ruto and Garrod 2009). Additional attributes linked to the specific case studies are discussed such as the width of pesticide free buffer zones (Christiensen et al., 2011), cattle and tree density in measures for the protection of a specific forest ecosystem (Santos et al., 2015), the possibility to conduct local pesticide treatment in vineyards (Kuhfuss et al.,

2015), the possibilty to go back to agriculture at the end of contract (Lienhoop and Brouwer, 2015), or contracts linked to afforestation and effect of spatial variables (Broch and Vedel, 2012).

One of the reasons for the BO controversy is that BO requirements are much more restrictive for agricultural activity than some classic AES. Restrictive requirements lies particularly in the contract length, as the duration of the contracts is longer it is not possible to withdraw from these contracts and the management plans may lead to give up agricultural activities on the enrolled parcels. One can thus wonder if BO is compatible with agriculture. For instance, the very long term nature of the contracts may seem to be out of step with the fact that, in some countries like France, most of the farmers rent their lands for short to mid-term contracts. Compared to AES, BO schemes are also voluntary but they rely on the implementation of a regulatory requirement by farmers on behalf of developers. To our knowledge, only a few researches have dealt with the implementation of BO on arable lands using a CE approach. For example, Le Coënt and Calvet (2015) discuss the social norm involved in the choice of a farmer to carry on pure biodiversity conservation versus BO measures. In our contribution, we look at understanding what are the reasons that limit farmers to sign these contracts. Our hypothesis is that farmers' preferences for accepting BO contracts are not enough to meet BO requirements.

In some papers, bonuses for improving the number of signed AES have been added such as in Banerjee et al. (2014), Buckley et al. (2012) or Khufuss et al. (2015). These bonuses are most of the time based on a principle of a threshold reached by the farmers involved. Some studies are not limited to agricultural land, they may also involve ecological conservation or restoration contracts on private lands. A great part of the literature on bonuses is based on laboratory experiment. Proposed agglomeration bonuses are applied when reaching a specific spatial coordination of enrolled parcels, as for instance the protection or restoration of contiguous patches of land (Dreschler et al., 2010; Parkhurst et al., 2002; Parkhurst and Shogren, 2007; Watzold and Dreshler, 2013). Khufuss et al. (2015) particularly studied the effect of nudging respondents in order to improve the ecological patterns of conserved areas. Regarding BO, in organizational terms, it is more interesting if a smaller number of actors are involved in the restoration of ecosystems because it is a way to reduce transaction costs linked to this environmental policy implementation (e.g. Levrel et al., 2015; Vaissière and Levrel, 2015). Consequently, we do not seek for a maximum number of hectares of BO at the scale of a territory through neighbors' coordination. However, we want to know how far a farmer, as an individual, is ready to provide a more efficient measure. This is why we design a new bonus proposed to farmers for additional ecologically relevant measures. To our knowledge, this is the first time this type of bonus is proposed in a CE. Note that a complementary study of Schöttker et al. (2015), based on a theoretical economical-ecological model, tries to demonstrate if it is more ecologically efficient to buy lands and leave its management with external management organizations, or to rent lands and leave its management with landowners or managers for the duration of the contract.

2.2 Methodological options for our case study: the agricultural region of Picardy

2.2.1 The Picardy case study

Picardy is a northern French region including 70% of agricultural lands, 20% of forests, and 10% being urbanized and natural areas that are often under the property of cities (Figure 1).

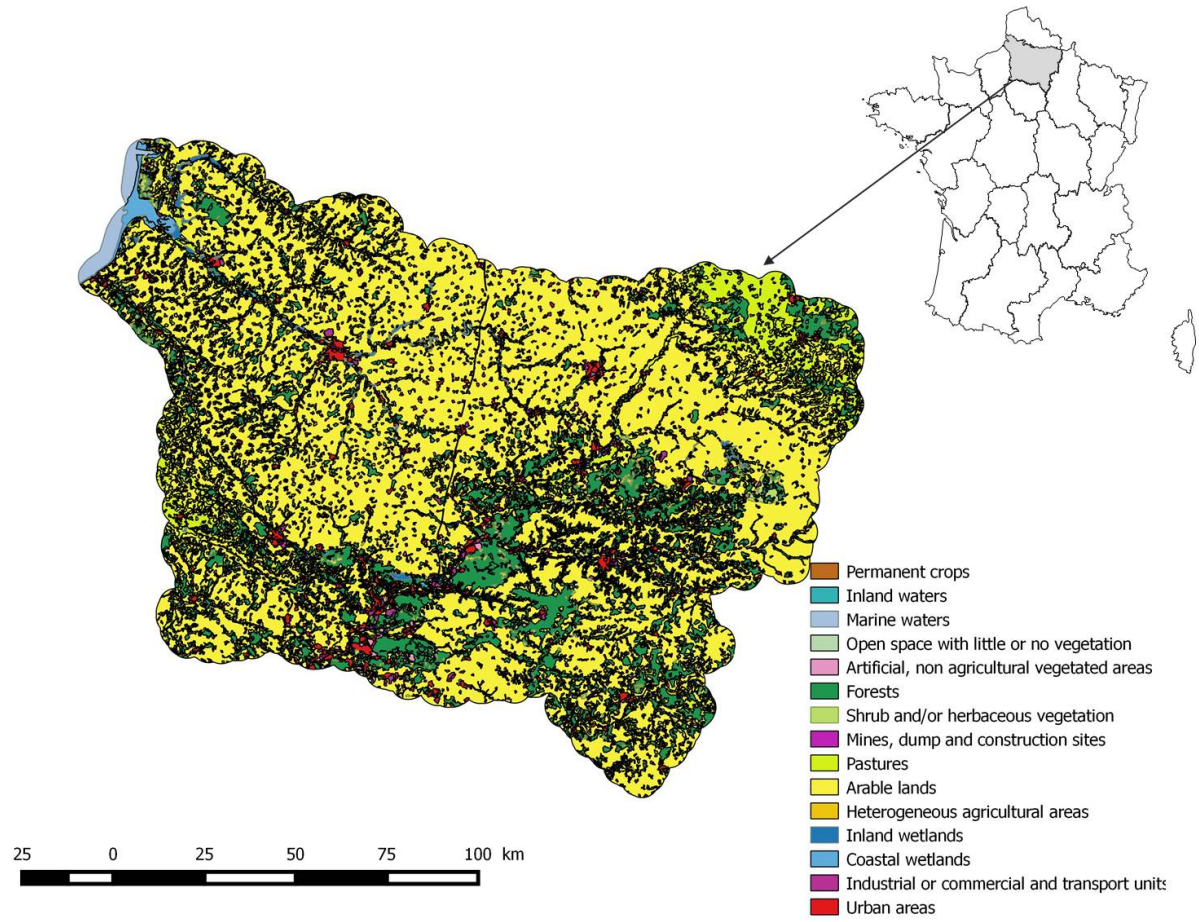

Figure 1: Land cover in the Case study region of Picardy

Farmers' opportunity costs for choosing an alternative use of their lands depends on the agricultural yield of the land, its value but also the Common Agricultural Policy (CAP) subsidies the farmers receive. Finally, there must be a cultural specificity of European, even a French one, due to a different regional planning and a specific relation to agriculture and nature[6]. Picardy holds many biodiversity issues related to several protected species living in the region such as the corncrake (*Crex crex*) or the stone-curlew (*Burhinus oedicnemus*), which are birds. Some messicole[7] populations are difficult to restore if there is not a seed bank on the soil, which is the case for instance for the hurtsickle (*Centaurea cyanus*).

[6] Gaucherand et al. (2015, p.245) underline the difference between French people that generally attaches importance to communities requiring continuous management as wet meadows, and Americans who tend to favor a stronger naturalness using "notions of 'old-growth' or 'pristine' to define the benchmark conditions against which to assess wetlands."

[7] Plants growing in crop lands.

2.2.2 *Modeling the farmer's decision to enroll in a BO contract*

Farmers' decision to enroll or not in a BO contract will result from the comparison of the utility they will derive from different alternatives. Following the Lancaster's theory (1966) and the random utility theory, the farmer *n* will choose alternative *i* in choice card C_t *(t=1,…,T)* if the alternative is the one that procures him the highest level of utility among all alternatives proposed in the choice card. The utility is defined by an observable part and a random part represented by error terms. In the Conditional Logit (CL) model, it is supposed that the error terms are independently and identically distributed (IID) among the alternatives and across the population, and that irrelevant alternatives are independent (IIA). If A_{int} is a dummy variable that takes the value of 1 if alternative *i* is chosen by farmer *n* in the choice card C*t*, the probability related to this choice is:

$$P(A_{int} = 1) = \frac{\exp\left(X'_{int}\beta\right)}{\sum_{j \in C_t} X'\beta}$$

With X_{int} the attributes of the contract *i* faced by farmer *n*, and β the vector of *k* preference parameters, representing the average importance of each attributes of the BO contract on the farmers' preferences. In order to capture the heterogeneity of farmers' preferences, we then use a Mixed Logit (ML) model. ML model relaxes the IIA assumption and allows assessing the β_{kn} that are specific to each interviewee, and randomly distributed across the population.

To conclude, we use a latent class model that helps determining classes of interviewees having similar preferences and behavior regarding the BO contracts. Having information on these classes may be of interest for public policies since different types of contracts may be proposed to different profiles of farmers, according to their preferences.

2.2.3 *Questionnaire, attributes and choice cards*

We conducted three focus groups with local farm union-run bodies (*Chambres d'agriculture*) in Picardy. Focus groups included administrative people and/or farmers, who helped us to determine key characteristics of BO contracts (i.e., the attributes in our CE and their levels) and to make the most realistic scenarios and follow up questions. A pilot survey was finally conducted with 26 farmers of Picardy to test the questionnaire accuracy and form.

The questionnaire was developed in three main parts. In the first part, we present the actual legal framework of BO in France to farmers who are not necessarily well informed. Afterwards, we describe a fictive development project that would occur in their region and imply a destruction of meadows of ecological interest. The developer would need to carry out BO in order to compensate for this ecological loss and would propose the farmers to sign a BO contract (without involving a sale of the lands). In case the farmer accepts one of the two BO contracts proposed, he would implement the management plan of the BO on arable lands on his farm on behalf of the developer and would be paid for that service. In the converse case, the farmer can decline the offer and keep his current agricultural practices by choosing the status-quo option. The eligibility rules and minimal terms and conditions of the contract are described in the questionnaire as follows: the measures have to be additional with other regulatory obligations (e.g., from the CAP); farmers would be accompanied by relevant technical and administrative staff from the local farm union-run bodies, or other naturalist public agencies or NGOs; farmers must agree to give access to their land for ecological monitoring and compliance control by regulators; in addition, none of the parties of the BO contracts can give it up.

Four attributes describe the BO contracts (Table 1):

The first attribute describes the *management plan* required by the BO contract. The BO has a common base for the fourth possible levels. The base includes technical details such as the fact that measures must be the restoration of meadows on arable cultivated lands of at least 10 meters wide and 0.5 ha of surface with a mix of seeds of legumes and grasses, and its management must be mowing. Details regarding mowing are also provided (centrifugal, forbidden at night, of a 15 cm minimum height etc.). As detailed in Table 1, the four levels of the attributes are a combination of a quantity of azote (N) fertilization, a specific date for mowing and the presence or not of a refuge zone (i.e., a zone of the meadow of at least 10 meters wide representing 10% of the surface of the BO that is not mowed and that can be moved each year). These BO requirements are very close to the contracts a farmer would be confronted by in a 'real life' situation. This is also true for the second attribute related to the contract duration.

The *durations of the contract* are frequently mentioned as an important factor of enrollment and are likely to be determinant in the case of BO contracts. After the focus groups consultation, durations chosen were 9, 18, 25 or 40 years (that cannot be terminated during the contract period).

The third attribute is the *monetary bonus for the respect of additional ecologically relevant measures*. The bonus is proposed in some scenarios and can be accepted or not by the farmers. The two levels for this attribute are thus "available" or "not available" in the scenarios. If the bonus is available, the farmer may decide to activate this bonus implying a 200€/ha/year[8] additional payment to the classical payment. However, this bonus is received under the following conditions: the farmers sign the contract for the scenario for at least 5 ha and the restored lands must be placed in one piece or following an ecological network on the farm.

Finally, a classical *payment* attribute – the fourth attribute – of 800, 1100, 1500 or 2000 €/ha/year[9] is proposed for each scenario. The lowest limit of these amounts has been chosen based on unit AES (e.g. restore and manage a meadow (EU COUVER06 or EUCOUVER07), reduce or stop fertilization on a parcel (EU HERBE02 or EU HERBE03) or delay mowing (EU HERBE06)) and then discussed and adjusted with the help of focus groups. Proposing a large range of payments allows us to measure the WTA of the most reluctant farmers to a change of agricultural practices.

[8] It was originally a 100€/ha/year bonus but it has been adjusted following the pilot study.
[9] It was originally a 400 to 1100€/ha/year payment but it has been adjusted following the pilot study.

Table 1: Attributes and attributes levels chosen to describe BO scenarios proposed to farmers

BO attributes	Description	Levels of BO attributes
Management plan	Levels of management plan required by the BO contract related to: quantity of azote fertilization (UN), date of mowing, and presence of a refuge zone	Dummy variable: Level I: 30 UN, June 20th, no refuge zone Level II: 0 UN, June 20th, no refuge zone Level III: 0 UN, July 20th, no refuge zone Level IV: 0 UN, July 20th, refuge zone (reference)
Contract duration	Total duration of the BO contract	Quantitative variable: 9, 18, 25, or 40 years
Conditional monetary bonus	Additional payment (200€/ha/year) for ecologically relevant measures, provided that the bonus is available in the scenario	Dummy variable: Yes (200€/ha/year), No (reference)
Payment	Payment received each year by the farmer per enrolled hectare	Quantitative variable: 800€/ha/year, 1100€/ha/year, 1500€/ha/year, or 2000€/ha/year

In order to understand which of the four attributes are the most important to farmers, we must combine their different levels in scenarios that describe different types of BO. For instance, a possible scenario is to carry out the level 3 management plan during 40 years with no bonus for 1100€/ha/year. The full factorial design generates 128 different scenarios, that is too much for the interviewees to answer. We used the SAS software and its command %mktruns to decide how many scenarios to propose to interviewees. The design for our CE must consist of 16 different combinations. We gathered the scenarios in pairs in 8 choice cards and we added to each choice card an opt-out answer entitled "I prefer to keep my current agricultural practices". The use of an opt-out answer is supposed to improve the realism of the choice cards and hence of the estimations of the models (Adamowicz and Boxall, 2001; Kontoleon and Yabe, 2003). The farmers thus must answer which BO they would agree to carry out on their farm. If they have selected one of the measures, an additional question appears: we ask them how many hectares they would be able to commit to the selected BO and how many of these hectares they own. It will be a way for us to understand if the farmers are ready to enter into discussion and negotiation with their potential owners of the land they are cultivating. It is possible that the farmers have a utility for other attributes that we did not selected in our CE, it will be transferred to the Alternative-Specific Constant of the model (ASC) (Adamowicz et al, 1994).

We selected the choice cards using an orthogonal efficient design with all the prior parameters set to 0 in order to determine the specific prior parameters of our sample (using the NGene software). Our D-error was worth 0.020317 that is acceptable. We analyzed the results of the pilot study with a Multinomial Logit Model (MNL) in order to get a better idea of the value of the prior parameters for each attribute, or for each level of attribute for the dummy variables, and then minimize the variance.

Then, the questionnaire has been adjusted based on feedback from farmers having filled the pilot survey. We raised the payment for the measures and the bonus, and we replaced the long explanation texts by concise and playful videos. We selected the choice cards using a Bayesian efficient design using the parameters having been revealed during the previous pilot study (still using the NGene software). Bayesian prior parameters are becoming more and more used over the past few years. It enables to have random priors around the value of the prior parameters having been determined with the pilot study. In order to minimize the approximation error when calculating the Bayesian efficiency, we use a Gaussian quadrature. Because we have six priors parameters, the Gaussian quadrature might need a large number of raws so we decided to include *;bdraws = gauss(3)* in our design. Figure 2 is an example of a choice card from the final study. The latter is currently being launched, it will be sent to all the available email addresses of the Picardian farmers.

Attributes	**Theoretical measure A**	**Theoretical measure B**	**None of the measures**
Management plan	**Level 2** Maximum fertilization: 0 UN Delayed mowing: June 20th no refuge zone	**Level 3** Maximum fertilization: 0 UN Delayed mowing: July 20th no refuge zone	I prefer to keep my current agricultural practices
Contract duration	25 years	18 years	
Conditional monetary bonus	B The measure proposes a 100€/ha/year bonus if you meet the requirements of the bonus	B The measure does not propose a bonus	
Payment	1 100 €/ha/year	800 €/ha/year	
Your choice:	Measure A ☐	Measure B ☐	None of them ☐

Figure 2: One of the 8 choice cards of the final survey for the choice experiment

In addition to the CE, we have built follow up questions with the help of the focus groups to understand BO in arable lands. These questions are aimed at better characterizing the respondents, almost for the use of the RPL and latent class models, and at improving our analysis of the results. Among these questions, we asked respondents if they focused their answers on one specific attribute or, on the contrary, if they systematically did not take into account an attribute, in order to reveal possible attribute non-attendances. Based on the discussions we had during the focus groups, we built two tables with possible threats and opportunities of BO for famers. These questions will help us to better characterize the profiles of our respondents and their relationship to risk. Depending on their answers during the CE, we asked specific question to those who systematically choose the opt-out answer and to those who choose at least one time the opt-out answer. It will be a way to identify the protest responses that must be removed from the analyzed sample (Windle and Rolfe, 2013 in Greiner et al. 2014). The end of the questionnaire includes questions about the farmers, their socio-economical profile, details about their farms and their relation to nature and biodiversity. Furthermore, we got information on the zip code of each respondent so it allows for crossing information on the measures these farmers would implement and other biodiversity and nature conservation information. Further spatial analysis, linked to answers regarding the bonus for additional ecologically relevant contractual terms, should then be discussed.

The surveys are proposed to farmers using Lime Survey, an on-line survey application. The time to fill the study is supposed to be 15-20 minutes. This approach is well suited for our case study. Firstly, farmers in this French region are quite well connected to Internet and usually use this communication means. Secondly, this method enables us to propose to the total (and numerous) sample of famers from Picardy to fill the enquiry. Thirdly, it is often considered that web-based enquiries limit bias linked to the presence of the interviewer.

3 Results on the model from the pilot study

The results in this version of the paper are based on the answers from the pilot study. The results of the final survey are still in the process of being acquired and will be presented at the time when the conference will be held. The results of the pilot study (26 answers of which we removed 4 answers that were protest answers) provide the likely direction of the parameters and of the value of the parameters that is useful to create the design of the final study (Table 2). The payment has a significant positive utility for farmers. The contract duration has a significant negative utility for farmers. The different management plan levels seem to have in turns positive and negative utility for farmers. The conditional monetary bonus seems to have a positive utility for farmers. The fact the ASC is different from 0 means that the farmers do have a utility for other attributes that we did not selected in our CE. However, regarding the size of the pilot study, the significance of the results is probably not accurate.

Table 2: Conditional logit model estimations

Parameters	Coefficient (*β*)	Standard error
Management plan Level 1	0.8204745*	0.4822475
Management plan Level 2	0.2382639	0.5177059
Management plan Level 3[a]	0.3623692	0.4624306
Contract duration	-0.1042324***	0.0206159
Conditional monetary bonus	0,2284689	0.3465993
Payment	0.0023151***	0.0004635
ASC[b]	2.393098***	0.6514846
N (observations)	528	
N (individuals)	22	
LR χ^2	154.44	
Prob > χ^2	0.0000	
Pseudo R^2	0.3994	
Log likelihood	-116.1362	

[a] Management plan level 4 is used as the reference parameter

[b] Alternative Specific Constant (ASC)

Significant levels: *p-value < 0.10, ** p-value < 0.05, *** p-value < 0.01

4 Discussion and conclusion

A structural limit of the implementation of BO on arable lands is that the compensation is supposed to last a finished period, and preliminary results of this study suggest that the length of the contracts is one of the attribute for which farmers are reluctant to sign contracts, while the impacts of development project are most of the time permanent. Indeed, farmers seem to be reluctant to long lasting contracts because they are most of the time not the owners of the land they cultivate and because these contracts would imply a transfer of the obligations to the future growers of these lands. With this scheme, the implementation of BO on arable lands can only slow down the degradation of the territory without any possibility to compensate for its impacts and hence lead to a no net loss of biodiversity. It is moreover unfortunately true since only protected and specific habitats and/or species are concerned by the mitigation hierarchy, not the ordinary ones. This result may be specific to Europe, amongst others due to the Common Agricultural Policy that certainly modifies the behaviors of farmers. For instance, in the USA, many farmers decide to turn their non-profitable arable lands to an innovative BO type, mitigation banks, implying the signature of a perpetual conservation easement that limits forever most of, or even any, agricultural practices (Vaissière and Levrel, 2015). We must thus be careful when transferring feedback or knowledge about foreign public policies to Europe because stakeholders' preferences may differ, based on a different spatial planning, history and culture. The result of this study would thus be transferable for many similar quite intensive agricultural regions in France, such as Beauce, or elsewhere in Europe.

For future research, it would be interesting to have information on the nature of the lands on which farmers would agree to carry out BO in order to assess the respect of the no net loss with a functional approach. Indeed, according to the impacted area, a pristine wetland or an arable land containing interesting ecological features (such as wetland function residues), BO requirements are not the same. In this study, it seems that farmers are quite reluctant to carry out very restrictive and

complex management plans. Consequently, it is difficult to consider that the measures they are ready to carry out could be relevant for compensating for impacts on high quality wetlands. If a pristine wetland is impacted and restoration actions only consist in a light change of agricultural practices (such as level 1 management plans) in degraded lands, the ecological loss are greater that the ecological gains and many hectares of agricultural lands would have to be involved in the BO in order to possibly reach an ecological equivalency. However, if an impact occurs on a highly degraded agricultural land that still has some wetlands features, even level 1 types of BO may be interesting. Preliminary results suggest that farmers would not agree to implement long term ambitious BO with strong ecological lift, so it is useless and risky for environment to approve these situations. Regulators should consider BO on agricultural lands only for impacts on already much degraded areas and potentially for temporary impacts.

Acknowledgments

Our thanks go to the LabEX CEMEB, the University of Montpellier (UMR LAMETA) and Biotope for supporting this work. This study also received funds from the European Union (FP7/2007-2013) with the contract 308393 “OPERAs”. We would like to thank Jens Abildtrup, Marion Beaurepaire, Miguel Da Costa Nogueira, Laure Khufuss, Philippe Le Coënt, Michel Pech, Raphaële Preget, Jean-Marc Rousselle, Sophie Thoyer and Gengyang Tu who were pretty helpful. The local farm union-run bodies (*Chambres d’agriculture*) of Picardy participated to focus groups and relayed the inquiry to the farmers.

References

Adamowicz, W., Boxall, P., 2001. Future Directions of Stated Choice Methods for Environment Valuation. Paper prepared for: Choice Experiments: A New Approach to Environmental Valuation April 10, 2001 London, England

Adamowicz, W., Louviere, J., Williams, M., 1994. Combining Revealed and Stated Preference Methods for Valuing Environmental Amenities. *Journal of Environmental Economics and Management*, 26(3): 271–292.

Baker, J., Sheate, W.R., Phillips, P., Eales, R., 2013. Ecosystem services in environmental assessment – Help or hindrance. *Environmental Impact Assessment Review*, 40: 3–13.

Banerjee, S., deVries, F.P., Hanley, N., van Soest, D.P., 2014. The Impact of Information Provision on Agglomeration Bonus Performance: An Experimental Study on Local Networks. *American Journal of Agricultural Economics* (June 16): aau048.

Bougherara, D., Ducos, G., 2006. Farmers' preferences over compensation contract flexibility and duration: an estimation of the effect of transaction costs using choice experiment. 1ère Journée de l'European School on New Institutional Economics (ESNIE), Université de Paris-Sud XI, France, 26 p.

Broch, S.W., Strange, N., Jacobsen, J.B., Wilson, K.A., 2013. Farmers' willingness to provide ecosystem services and effects of their spatial distribution. *Ecological Economics*, 92 : 78–86.

Broch, S.W., 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(4): 561–581.

Buckley, C., Hynes, S., Mechan, S., 2012. Supply of an Ecosystem service—Farmers' Willingness to Adopt Riparian Buffer Zones in Agricultural Catchments. *Environmental Science & Policy,* 24 Special Issue on Catchment Science and Policy Evaluation for Agriculture and Water Quality : 101–109.

Burylo, M., Regnery, B., Julliard, R., Quenouille, B., 2013. Compenser aussi la perte de services écologiques. *Espaces Naturels*. 41: 18.

CBD and UNEP-WCMC [Secretariat of the Convention on Biological Diversity and the United Nations Environment Programme-World Conservation Monitoring Centre], 2012. *Best policy guidance for the integration of biodiversity and ecosystem services in standards*, Montreal, Technical Series No. 73, 52 pp.

Chen, X., Lupi, F., He, G., 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(28) : 11812–7.

Christensen, T., Pedersen, A.B., Nielsen, H.O., Mørkbak, M.R., Hasler, B., Denver, S., 2011. Determinants of farmers' willingness to participate in subsidy schemes for pesticide-free buffer zones - A choice experiment study. *Ecological Economics*, 70(8): 1558–1564.

de Billy, V., Tournebize, J., Barnaud, G., Benoît, M., Birgand, F., Garnier, J., Lesaffre, B., Lévêque, C., de Marsily, G., Muller, S., Musy, A., Zimmer, D., 2015. Compenser la destruction de zones

humides. Retours d'expériences sur les méthodes et réflexions inspirées par le projet d'aéroport de Notre-Dame-des-Landes (France). *Natures Sciences Sociétés*, 23(1): 27–41.

Drechsler, M., Wätzold, F., Johst, K., Shogren, J.F, 2010. An Agglomeration Payment for Cost-effective Biodiversity Conservation in Spatially Structured Landscapes. *Resource and Energy Economics* 32 (2) Spatial Natural Resource and Environmental Economics Papers from a Workshop at the University of Wyoming, Department of Economics and Finance September 2008 (April): 261–275.

Espinosa-Goded, M., Barreiro-Hurlé, J., Ruto, E., 2010. What Do Farmers Want From Agri-Environmental Scheme Design? A Choice Experiment Approach. *Journal of Agricultural Economics*, 61(2) : 259–273.

Etrillard, C., Pech, M., 2015. Mesures de compensation écologique : risques ou opportunités pour le foncier agricole en France ? *Vertigo*, 15(2).

Gaucherand, S., Schwoertzig, E., Clément, J.C., Johnson, B., Quétier, F., 2015. The cultural dimensions of freshwater wetland assessments: lessons learned from the application of US rapid assessment methods in France. *Environmental Management*, 56(1): 245–59.

Greiner, R., Bliemer, M., Ballweg, J., 2014. Design Considerations of a Choice Experiment to Estimate Likely Participation by North Australian Pastoralists in Contractual Biodiversity Conservation. *Journal of Choice Modelling* 10: 34–45.

Kontoleon, A., 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 and Research*, 5 : 1–43.

Kuhfuss, L., Préget, R., Thoyer, S., 2014. Préférences individuelles et incitations collectives : quels contrats agroenvironnementaux pour la réduction des herbicides par les viticulteurs ? *Revue d'Etudes en Agriculture et Environnement - Review of Agricultural and Environmental Studies*, 95(1): 111–143.

Kuhfuss, L., Préget, R., Thoyer, S., Hanley, N., 2015. Nudging Farmers to Enrol Land into Agri-environmental Schemes: The Role of a Collective Bonus. *European Review of Agricultural Economics* (October 31): jbv031.

Lancaster, K., 1966. A new approach to consumer theory. *Journal of Political Economy*, 74 : 132–157.

Le Coënt, P., Calvet, C., 2015. Challenges of achieving biodiversity offsetting through agri-environmental schemes: evidence from an empirical study. Working paper at the 9th *Journées de Recherches en Sciences Sociales*, Nancy, 10th-11th of December 2015.

Levrel, H., Frascaria-Lacoste, N., Hay, J., Martin, G., Pioch, S. (eds.), 2015. *Restaurer la nature pour atténuer les impacts du développement - Analyse des mesures compensatoires pour la biodiversité*. Editions QUAE.

Lienhoop, N., Brouwer, R., 2015. Agri-environmental Policy Valuation: Farmers' Contract Design Preferences for Afforestation Schemes. *Land Use Policy,* 42 : 568–577.

Luce, R.D., 1959. Individual Choice Behavior: A Theoretical Analysis. New York: Wiley.

McFadden, D. 1974. Conditional logit analysis of qualitative choice behavior. In : Zarembka, P. (ed.), 1974. *Frontiers in Econometrics*, New York: Academic Press, 105–142.

MEDDE, 2013. Lignes directrices nationales sur la séquence éviter, réduire et compenser les impacts sur les milieux naturels.

MEDTL, 2012. Doctrine relative à la séquence éviter, réduire et compenser les impacts sur le milieu naturel.

Parkhurst, G., Shogren, J., 2007. Spatial Incentives to Coordinate Contiguous Habitat. *Ecological Economics,* 64(2) Special Section - Ecosystem Services and Agriculture : 344–355.

Parkhurst, G., Shogren, J., Bastian, C., Kivi, P., Donner, J., Smith, R., 2002. Agglomeration bonus: an incentive mechanism to reunite fragmented habitat for biodiversity conservation. *Ecological Economics*, 41(2) : 305–328.

Ruto, E., Garrod, G., 2009. Investigating farmers' preferences for the design of agri-environment schemes: a choice experiment approach. *Journal of Environmental Planning and Management,* 52(5): 631–647.

Santos, R., Clemente, P., Brouwer, R., Antunes, P., Pinto, R., 2015. Landowner Preferences for Agri-environmental Agreements to Conserve the Montado Ecosystem in Portugal. *Ecological Economics,* 118 : 159–167.

Schöttker, O., Johst, K., Drechsler, M., Wätzold, F., 2015. Land for biodiversity conservation – to buy or borrow? *17th Annual BIOECON Conference Experimental and Behavioural Economics and the Conservation of Biodiversity and Ecosystem Services*, 13-15 September 2015, Cambridge, United Kingdom.

Tardieu, L., Roussel, S., Thompson, J.D., Labarraque, D., Salles, J.M., 2015. Combining direct and indirect impacts to assess ecosystem service loss due to infrastructure construction. *Journal of Environmental Management*, 152: 145–157.

Vaissière, A.C., Levrel, H., 2015. Biodiversity offset markets: What are they really? An empirical approach to wetland mitigation banking. *Ecological Economics,* 110 : 81–88.

Wätzold, F., Drechsler, M., 2014. Agglomeration Payment, Agglomeration Bonus or Homogeneous Payment? *Resource and Energy Economics,* 37 : 85–101.

Windle, J., John, R., 2014. Assessing the Trade-offs of Increased Mining Activity in the Surat Basin, Queensland: Preferences of Brisbane Residents Using Nonmarket Valuation Techniques. *Australian Journal of Agricultural and Resource Economics,* 58 (1): 111–129.