Challenges of achieving biodiversity offsetting through agri-environmental schemes: evidence from an empirical study

Philippe Le Coent, Coralie Calvet

LAMETA

Laboratoire Montpelliérain d'Economie Théorique et Appliquée

U M R

Unité Mixte de Recherche

DOCUMENT de RECHERCHE

« Challenges of achieving biodiversity offsetting through agri-environmental schemes: evidence from an empirical study »

Philippe LE COENT
Coralie CALVET

DR n°2016-10

Unite de Formation et de Recherche d'Economie
Avenue Raymond DUGRAND C.S. 79606
3 4 9 6 0 MONTPELLIER Cedex 2

E-mail : lameta@lameta.univ-montp1.fr

Challenges of achieving biodiversity offsetting through agri-environmental schemes: evidence from an empirical study.

Philippe Le Coent[a] and Coralie Calvet[b]

[a] Université Montpellier 1, UMR 5474 Lameta, 2 place Pierre Viala, 34000 Montpellier, France.
[b] Université d'Avignon et des Pays de Vaucluse, INRA-UR0767 Ecodeveloppement, Site Agroparc, Domaine St Paul, CS 40509, 84914 Avignon, Cedex 09, France.

Reference to cite the article:

Le Coënt, P.[a], **Calvet, C.**[b], 2015. Challenges of achieving biodiversity offsetting through agri-environmental schemes: evidence from an empirical study. *9[es] Journées de Recherches en Sciences Sociales de la Société Française d'Economie Rurale (SFER)*, Dec. 10-11, Nancy, France.

[a] Université Montpellier 1, UMR 5474 Lameta, 2 place Pierre Viala, 34000 Montpellier, France.

[b] Université d'Avignon et des Pays de Vaucluse, INRA-UR0767 Ecodeveloppement, Site Agroparc, Domaine St Paul, CS 40509, 84914 Avignon, Cedex 09, France.

Abstract

Biodiversity offsetting (BO) is increasingly used in environmental policies as a way to halt biodiversity losses caused by the development of infrastructure and urbanization. Ecological gains for offsets have so far mainly been obtained through restoration activities conducted on agricultural land specifically acquired for this purpose by developers. This approach however meets growing technical difficulties due to land availability and social conflicts with farmers. The purpose of this paper is to analyse the opportunity of implementing a new approach to conduct biodiversity offsets through the use of agri-environmental schemes that we call agri-environmental biodiversity offset schemes (ABOS). This paper reviews the interests, limits and challenges of the use of ABOS in offsetting policies by examining two major issues: (1) the acceptability of offsetting contracts by farmers, and (2) the effectiveness of ABOS design and implementation. Based on the case-study of a major BO programme following the construction of a big railway bypass in the South of France, the article empirically assesses these issues through a survey carried out with 145 farmers. The results reveal that the main determinants of acceptability are: i) the usual economic factors - farmers with lowest compliance levels and opportunity costs, as well as farms facing economic difficulty, are more likely to adopt -, and ii) social factors – the importance given to other farmers' decision and the feeling that this decision is accepted by farmers' representatives. In terms of effectiveness, ABOS is shown to be effective in meeting legal requirements of the developer, but concerns are raised about real ecological benefits due to issues of additionality, permanence of land use change, and 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 agri-environmental schemes. These results raise questions about the relevance of developing ABOS in offsetting policies, and lead us to suggest policy improvements.

Keywords

Agri-environmental schemes; Biodiversity offsets; Conservation; No Net Loss Policies; Determinants adoption; Behavioral Economics

1. Introduction

Biodiversity offsetting (henceforth BO) is increasingly used in environmental policies as a way to halt biodiversity losses caused by the development of infrastructure and urbanization. This development represents one of the major threats on biodiversity due to the species' habitat destruction and fragmentation (Davenport et Davenport, 2006 ; Quintero et Mathur, 2011). In France, as a regulatory requirement, BO is incorporated in a mitigation hierarchy aimed at avoiding, minimizing, and in a last resort, offsetting for residual impacts on biodiversity. The principle of BO is to achieve a "No Net Loss" (henceforth NNL) of biodiversity by counterbalancing residual losses resulting from impacts of a development project at one place with ecological gains provided elsewhere (but in a relatively close geographical area according to institutional contexts) (Bull, Suttle, Gordon, et al., 2013). BO requirements appeared in environmental legislations of many countries in the 1970s, but they were rarely implemented in practice (McKenney et Kiesecker, 2010 ; Quétier, Regnery et Levrel, 2014). Recently, the concept of BO has known an important surge of interest in the political arena associated with recent initiatives aimed at achieving "No Net Loss of biodiversity and ecosystem services by 2020" (CBD et UNEP, 2010 ; European Commission, 2011).

Ecological gains for offsets can be provided in three different ways: i) by creating a new natural area, ii) by giving protected status to preserve an existing natural area, and iii) by restoring or improving ecosystems and their functions (for instance habitats for species). In relation with the NNL goal, offset measures must be additional to existing actions for biodiversity and ecosystems. In this perspective, restoration or improvement actions are the most used practices in offsetting schemes because they allow providing a real additionality of offsets (Gardner et al., 2013). In practice, ecological restoration within offset schemes is mainly carried out on agricultural land in two main ways: by acquisition of land or by contracting with landowners (McKenney et Kiesecker, 2010).

In densely populated regions in which natural areas are shrinking, the recent development of biodiversity offsets through ecological restoration faces major practical problems. It is becoming increasingly difficult to find and acquire new land to implement offsets close to development projects due to strong urban sprawl and infrastructure development. The rapid land-use change in European countries over the past four decades has increased the pressure on land in urban and suburban areas (Perrier-Cornet, 2004). This leads to stronger social conflicts especially with farmers who try to maintain their activity in this fast-moving environment (Perrier-Cornet and Hervieu, 2002). In the case of offsets policies, farmers actually speak about a “double punishment” because agricultural land is first lost because of infrastructure construction, and second, because of the implementation of offset measures (Zakine, 2014). In this context, implementing BO objectives through the acquisition of agricultural land is becoming increasingly difficult.

A possible way out of this conflict is to make the implementation of BO compatible with agriculture activities by implementing contracts with farmers. This requires changing or adapting agricultural practices and/or land use because biodiversity on agricultural land largely depends on the intensity of land use and practices (Tilman et al., 2001). Encouraging farmers to change their practices for environmentally friendly ones, through appropriate incentives, could therefore be a way to conduct BO. This approach has been pursued in the EU Common Agricultural Policy (CAP) with the use of agri-environmental schemes (henceforth AESs), considered as the main policy instrument to preserve biodiversity in agricultural landscapes (EEA, 2004). AESs are voluntary contracts in which farmers are offered compensation payments for reducing the negative externalities of agricultural production or producing positive externalities. This can be done by reducing the intensity of agriculture systems or by maintaining extensive systems with positive impacts on the environment.

Implementing a new kind of AES, that we call Agri-Biodiversity Offset Scheme (henceforth ABOS), could therefore be a genuine opportunity to facilitate the implementation of biodiversity offsets, and encourage farmers to adopt pro-environmental practices. We define ABOS as one or a set of voluntary contract(s) in which a developer offers payments to one or several farmers for changing their practices to environmentally friendly ones, thus providing ecological gains that will serve as biodiversity offsets. European governments are increasingly interested in the use of these contracts for the implementation of offsets (Masden et al., 2011). In the draft biodiversity law, the French government is introducing farmers as new operators to implement offsets (Gaillard, 2014). ABOS therefore represents an emerging approach to organize the BO transaction under NNL policies.

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. To address this gap, this article sheds lights on the opportunities and limits of using ABOS in environmental policies. This mechanism presents a number of interests, particularly for developers, because its flexibility, its relatively low cost and its capacity to reduce local conflicts on land acquisition. However, using agro-environmental contracts for the implementation of BO targets presents two major challenges. The first challenge is that farmers must enrol in the programme and contracts proposed in ABOS must therefore be sufficiently attractive (acceptability) and the second one is that the scheme must induce actual practice or land use change that lead to the expected environmental benefits and must be sustained over time (effectiveness). We address these challenges through the empirical analysis of a vast BO programme implemented through ABOS in the South of France.

The article is organized into five main sections. The second section presents the theoretical framework of the study. It i) defines ABOS as regards to other kind of AES especially AESs in the CAP and Payment for Environmental Services (PES), ii) highlights the potential interests of developing ABOS for the different actors in biodiversity offset policies, and iii) describes the theoretical background of ABOS's challenges: mainly acceptability and effectiveness. The third section describes the methodology of the field research: (i) the case-study, (ii) the data collection, and (iii) the data analysis methodology. The forth section presents the results 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.

2. Theoretical framework: definition, interests and challenges of ABOS

2.1. Definition of ABOS

BO schemes involve a third-party transaction in which there are an offset buyer, the developer, an offset seller, the provider of ecological gains, and an offset regulator who requires the purchase of offset and controls its implementation (Coggan et al., 2013a ; Scemama et Levrel, 2014). We defined ABOS as one or a set of voluntary contract(s) in which a developer offers payments to one or several farmer(s) for changing their practices to environmentally friendly ones, thus providing ecological gains that will serve as biodiversity offsets. 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 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 13).

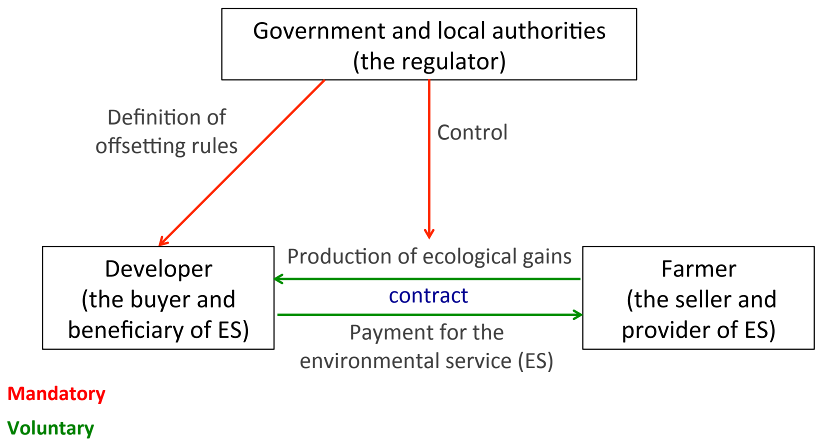

Figure 13. Schematization of Agri-Biodiversity Offset Schemes (ABOS) as a transaction in offset policies.

ABOS are very close to PES in which a beneficiary pays a provider for an environmental service. Like in PES schemes, the transaction between at least one buyer, beneficiary of the service, and one seller, provider of the service, is voluntary and conditioned to the provision of a well-defined environmental service (Wunder, 2005). As mentioned before, ABOS are also very close to AES implemented in the CAP. There are however specificities compared to PES or AES. First, ABOS must fulfil a regulatory requirement, so the motives for the transaction are not voluntary but framed within a regulatory framework. Depending on the level of ecological losses that remain after avoiding and reducing the impacts of a project, the developer will be set by the State a mandatory target of ecological gains to achieve through biodiversity offsets. Outcomes of AES and PES programmes are generally more loosely set and rather depend on available budget. This specificity imposes that ABOS actually achieve mandatory outcomes in terms of ecological gains. We will see in section 2.3 that effectiveness issues attached to all agri-environmental contracts may raise challenges for the attainment of these mandatory outcomes, mainly due to information asymmetry (Ferraro, 2008). Despite this constraint for the developer, transactions remain voluntary for the farmer in ABOS as for AES and PES. Second, in relation with the BO principle, ecological gains provided through ABOS serve to compensate for ecological losses. There is no overall gain of biodiversity as in PES and AES. Third, the beneficiary of the environmental service is in ABOS, in most cases, a private entity in contrast to PES and AES schemes in which this is mainly public beneficiaries (Wunder, Engel et Pagiola, 2008). These differences of objective and ultimate beneficiary may affect farmers' willingness to participate in the scheme due to individual preferences for one option or the other.

2.2. Potential interests of ABOS

The use of agri-environmental contracts for the implementation of BO objectives presents a number of potential interests as compared to other tools used for the implementation of BO such as mitigation banks or land acquisition.

First, the use of short-term agri-environmental contracts may be better accepted by farmers than land acquisition. Indeed, farmers consider that BO may accelerate the loss of agricultural land already affected by urbanization (Zakine, 2014). Farmers may be more favourable to ABOS that represent short-term commitment with the possibility to revert to previous land use after the end of the contract. Second, the cost of implementing such system that do not entail the cost of land acquisition is strongly reduced for developers especially in contexts where land prices are already high. These two points may facilitate the implementation of biodiversity offsets by developers.

Third, the flexibility of this system, with short-term contracts (usually 5 years), may have a number of advantages to adapt to potential future evolutions. Indeed, it is expected that due to climate change, the spatial distribution of species may change over time (Devictor et al., 2012) and may perhaps require a spatial adaptation of BO ((Bull, Suttle, Singh, et al., 2013). In addition, legal and administrative obligations attached to BO have evolved quickly in the recent past and may continue to do so. Using ABOS may allow developers to adjust to potential future modifications of legal and administrative rules. Another aspect is that BO still rely on incomplete and imprecise scientific knowledge regarding biodiversity and conservation issues (Calvet, Napoléone et Salles, 2015). These uncertainties may require adjustments of BO implementation over time that would be facilitated by the use of rapidly adjustable ABOS.

Fourth, as compared to mitigation banks that are more suitable to compensate for generic assets (Scemama et Levrel, 2014), ABOS can be used to compensate more specific biodiversity losses being tied to a specific development project.

Fifth, the use of ABOS is particularly adapted for the compensation of biodiversity tied to agricultural activities (Cimon-Morin, Darveau et Poulin, 2013 ; Ribaudo et al., 2010). In European countries, the intensification of agriculture has been shown as a major cause of biodiversity decline especially for species that are strongly dependent on agricultural lands as steppic birds (Burfield, 2005; Donald, Green et Heath, 2001). However, some agricultural systems can benefit to this biodiversity and foster its development by providing habitats and food (Wolff et al., 2001b). In addition, the use of ABOS may also have spill over effects as it may induce farmers to adopt practices and land use that are more favourable for biodiversity not only on land under contract, for example through an evolution of social norms (Pattanayak, Wunder et Ferraro, 2010). The existence of ABOS may also represent an economic opportunity, especially for farms that are in difficulty. One other spillover effect could therefore be that ABOS contribute to the survival of some farms and the maintenance of agriculture activities, which will in turn have an effect on agro-biodiversity at the landscape scale.

2.3. Challenges of ABOS

We presented the numerous interests of ABOS that may facilitate the implementation of BO. However, the use of agri-environmental contracts in the context of biodiversity offsets raises specific challenges as compared to land acquisition, the main tool used in the implementation of BO. Indeed, the acquisition of land by developers allows a long-term control of land-use and agricultural practices whereas the use of ABOS, which are voluntary short-term contract with farmers, do not provide the same level of control.

The first challenge is that farmers must enrol in the programme and contracts proposed in ABOS must therefore be sufficiently attractive (acceptability) and the second one is that the scheme must induce actual practice or land use change that lead to the expected environmental benefits and must be sustained over time (effectiveness).

2.3.1. 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 do this this several time during the legal duration of biodiversity offsets.

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 proposed in the Common Agricultural Policy. Acceptability of agri-environmental contracts is influenced by a diversity of determinants that can be classified into four main groups: farmer and farm socio-economic characteristics, contract characteristics, payment level and its relation to costs, and (4) behavioral factors (see details in Appendix 1). Acceptability of ABOS may be influenced by the same determinants but the particularities of ABOS may modulate their importance.

The following aspects may be particularly important in ABOS adoption:

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 et Ducos, 2006 ; Christensen et al., 2011 ; Louis et Rousset, 2010 ; Ruto et Garrod, 2009), leave more flexibility to farmers in plot selection (Bougherara et Ducos, 2006 ; Ruto et Garrod, 2009) and in technical prescriptions (Bougherara et Ducos, 2006 ; Christensen et al., 2011 ; Kuhfuss, Preget et Thoyer, 2014 ; Ruto et Garrod, 2009). Besides, easiness to withdraw from the contract is also an important criteria in farmers' participation (Christensen et al., 2011).

In the Common Agriculture Policy (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 the developer, which is generally a private firm. Thus, it is expected that ABOS be set in a more flexible way especially in terms of enforcement rules and eligibility criteria. Likewise, due to this flexibility, contract terms will probably be more easily renegotiated in a context of environmental or farm change. The higher flexibility offered by ABOS will likely have a positive influence on farmers' acceptability.

Payment/Cost

The relationship between costs and payment amounts is a key issue to understand the adoption of agri-environmental contracts (Brotherton, 1991 ; Drake, Bergström et Svedsäter, 1999) and is expected to similarly play a fundamental role for ABOS. A particularity, compared to AES especially, is that payments could theoretically be freely set during the transaction between the developer and land owners and therefore minimize acceptability issues. However, as we will see in our case study, many times the administration imposes a fixed-payment system based on the compensation of additional costs and foregone profits incurred by farmers, equivalent to the AES payment system. Concerning costs, ABOS should generally present less administrative constraints and restrictions than AES, mainly due to simpler procedure and contract terms, and are therefore supposed to entail reduced transaction costs and could be therefore more easily adopted than AES.

Social norms

The role of social norms in the adoption of AES and pro-environmental practices has been recently highlighted (Banerjee et Wossink, 2015 ; Beedell et Rehman, 1999 ; Fielding et al., 2005 ; Kuhfuss et al., 2015). This factor may be an important determinant particularly for the adoption of ABOS. Indeed, BO programmes are linked to the construction of infrastructure that may create local disturbance and may be associated with expropriation and vast land acquisition programmes. These factors may create local resistance to any actions associated with the construction project and social pressure not to adopt ABOS.

Attitude towards the environment

This factor is one of the prominent factors that have been shown to influence adoption of agri-environmental programmes (Beedell et Rehman, 2000 ; Defrancesco et al., 2008 ; Delvaux et al., 1999 ; Ducos, Dupraz et Bonnieux, 2009 ; Morris, Pottert et Potter, 1995 ; Mzoughi, 2011) although this importance raises debate (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 the construction of an infrastructure, and therefore might not be considered as a pro-environmental behavior, we anticipate that the attitude towards the environment may have a rather limited importance.

Trust

Trust between contracting partners also facilitates participation in AES by reducing transaction costs both before and during the transaction (Ducos, Dupraz et Bonnieux, 2009 ; Ducos et Dupraz, 2007 ; Louis et Rousset, 2010 ; Peerlings et Polman, 2009). In Europe, AES are generally struck between farmers and the State within the CAP framework. In the context of BO, actors that offer ABOS to farmers mainly 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.

2.3.2. Effectiveness 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) that land-use changes actually lead to environmental outcomes (*link between land use and environmental outcomes*) and that iv) changes must be sustained over time *(permanence)* (Wunder, Engel et Pagiola, 2008). We describe below the main issues related to this four challenges.

Compliance

Farmers are better informed about their actions than the developer. After the contract has been negotiated, it may be rational for farmers not to respect these terms if the developer does not invest enough in monitoring compliance or does not impose stringent sanctions (Ferraro, 2008).

Additionality

Additionality means that land-owners not only adopt land uses or agricultural practices but ones that they would not have adopted in the absence of ABOS (Wunder, Engel et Pagiola, 2008). Some farmers under ABOS may indeed adopt practices that are favorable for the restoration of habitats of species affected by the construction of an infrastructure but that they would have adopted anyway: this is called the windfall effect (Chabé-Ferret et Subervie, 2013 ; Kuhfuss et Subervie, 2015). Windfall effect should be avoided as much as possible because they do not bring extra ecological benefits and should not be taken into account in the attainment of the BO targets. If pre-contract diagnosis is not done properly, selected farmers may even get paid to implement practices that they already implemented before.

Information asymmetries that are therefore 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).

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 uses lead to actual ecological gains and that overall they compensate ecological damages. Several aspects need to be considered on this issue. First, the modification of land use and practices included in ABOS's requirements must actually lead to environmental benefits and the predicted benefits of each modification should be adequately quantified. This requires a solid expertise in the ecology of species affected by the damages. Second, schemes may need to be adapted when the marginal benefits from the service provision are not constant (Jack, Kousky et Sims, 2008). Threshold effects, that are relatively frequent in ecological systems (Muradian, 2001 ; Perrings et Pearce, 1994), require the implementation of schemes that ensure a minimum level of participation in order to avoid "paying for nothing" (Le Coent, Préget et Thoyer, 2014). Spatial coordination may also be required in order to achieve ecological results. Depending on the species, the conservation of habitats in the shape of corridors, patches or mosaic may be necessary (Forman, 1995). In this case, it is fundamental to integrate a landscape approach in the design and implementation of conservation programmes (Goldman, Thompson et Daily, 2007).

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, 2015). In the case of ABOS, the main goal is to avoid no net loss of biodiversity. This implies that the irreversible losses caused by development projects have to be offset by long term ecological gains. In this way, there is a major issue in maintaining the ecological gains provided by farmers' practices in ABOS. However, the literature shows that contracts with long duration are generally not well accepted by famers (Bougherara et Ducos, 2006 ; Christensen et al., 2011 ; Ruto et Garrod, 2009). This constraint implies either that land-use modifications required in the contracts are maintained after the end of contracts or that new contracts are periodically being signed with farmers for as long as the ecological impact of the infrastructure remains.

This theoretical section highlighted the interests and challenges tight to the use of agri-environmental contracts in biodiversity offsets. The purpose of the rest of the article is to confront these elements, mainly acceptability and effectiveness of ABOS, to an empirical analysis. We present in the following section the case-study and the methodology used to conduct such analysis.

3. Methodology of the field research

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 effectiveness of ABOS.

3.1. Presentation of the case-study

3.1.1. Brief history and description of the institutional organization

We study the use of ABOS for the implementation of part of the biodiversity offsets required to compensate the ecological impact of a big railway project in southern France. This project, named "rail bypass Nîmes-Montpellier" (henceforth CNM project), has been initiated in 2000 by Réseau Ferré de France (RFF), a public company which owned and maintained the French national railway network (Calvet and Quétier, 2014). The project includes the construction of an 80 kilometers mixed high-speed railway line between Nîmes and Montpellier (Figure 14).

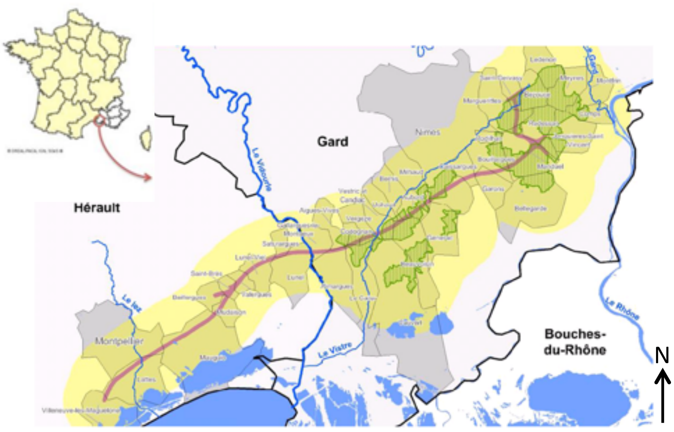

Figure 14: mapping of the CNM project (red line) among protected natural areas (green areas) (adapted from Oc'Via, http://www.ocvia.fr).

In 2012, through a public-private partnership, RFF delegated the construction and maintenance of the railway for 25 years to a private consortium of industrial and business corporations named “Oc’Via”. Regarding ecological aspects, Oc’Via contracted a company, named “Biositiv”, to take in charge ecological issues tied to the rail bypass project. Biositiv is an internal structure of the important builder Bouygues Construction aimed at accompanying developers in their strategy to biodiversity. Biositiv contracted the environmental consultancy company “Biotope” to conduct the environmental impact assessment of the CNM project and to define the biodiversity offsets needs (Figure 15).

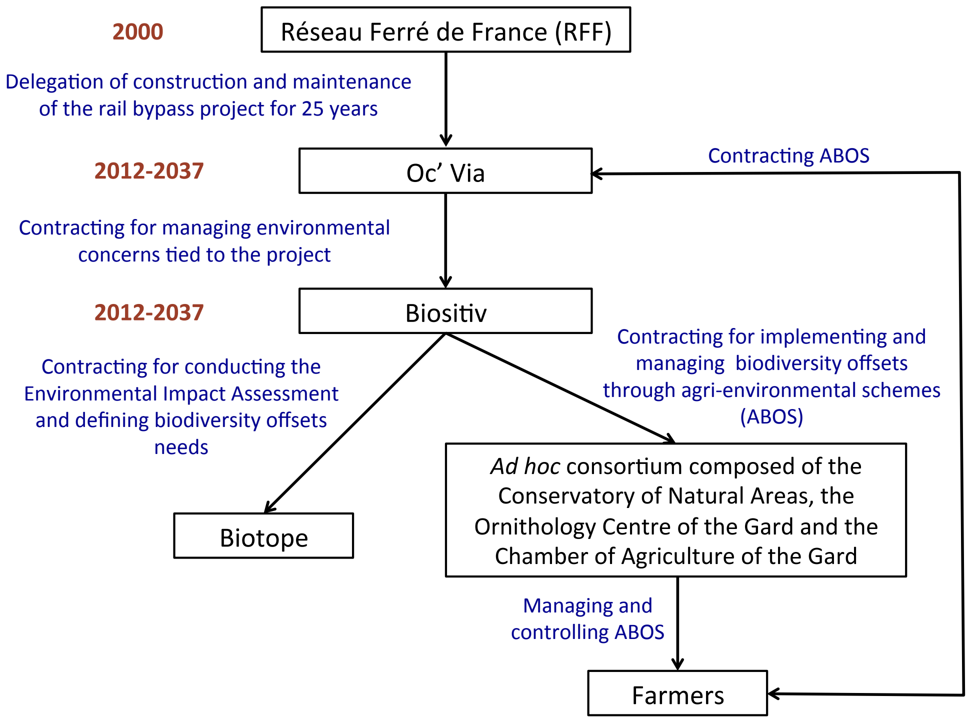

Figure 15: institutional organization of the biodiversity offsetting programme of the CNM project.

3.1.2. Ecological impacts

Due to the size and location of the CNM project, there are large ecological impacts. The railway line crosses two large Natura 2000 sites (see figure 14) in which the Mediterranean little bustards’ population is the largest of the French territory (Wolff, 2001a). The little bustard is listed on the red list of endangered species classified vulnerable in France and near-threatened at global scale (IUCN, 2012). Some habitats and species present in these sites are protected by EU Directives (EU Habitats and Birds Directives). The environmental impact assessments conducted by Biotope revealed that the CNM project would impact 1886 hectares of natural habitats due to disturbance-related impacts, and destroyed 652 hectares due to direct construction area. This project also affects more than 124 protected species by European Directives of which the majority are bird species. The little bustard is considered the central species due to the significance of the impacts on its habitat and its conservation status.

3.1.3. Definition of biodiversity offsets needs

Biotope assessed the need for biodiversity offsets tied to the CNM project by using a specific and innovative method to assess ecological equivalence between biodiversity losses and gains. This method allows replacing a per-hectare approach by a compensation units (CUs) approach to quantify impacts and offset needs (for a more detailed description of the method see Dauguet (2015)). The main objective of this approach is to highlight the "ecological added-value" of offsets by considering the ecological quality of habitats rather than their only surface areas. Thereby, two habitats of equal surface area can require a different amount of CUs depending on their ecological value. For instance, impacts on a high ecological value habitat will require more CUs than impacts on a lower ecological quality habitat. The same unit is used to estimate ecological gains in the BO programme. Ecological gains, in CU, depend on the change of land use and agriculture practices between before and after restoration (Figure 16).

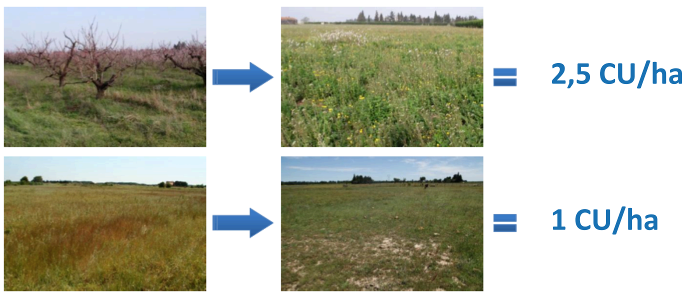

Figure 16. the Compensatory Unit (CU) approach used to assess gains attached to land-use change (adapted from Quétier et al. (2013)).

Through this approach, Biotope estimated a need of 3279 CUs to compensate for the impacts of the CNM project most of which are for the little bustard and related to agricultural land (95%). Oc'Via has thus to implement biodiversity offsets allowing the provision of 3279 CUs by April 2018. The environmental administration proposed a gradual attainment of this target. For instance, Oc'via had to provide 3071 CUs by April 2015. Oc'Via legal commitment related to biodiversity offsets will last 25 years, meaning that he has to maintain the total of 3279 UCs until 2037.

Depending on the ecological value provided by the different biodiversity offsets (according to the CU approach, see figure 16), the need of offsets was estimated at around 1600 hectares among which 500 hectares would be acquired and restored in favourable habitats for little bustards, and 1100 hectares would be contracted with farmers through ABOS.

3.1.4. Implementation of ABOS

Our study only focuses on the offsets conducted through ABOS. In order to implement and conduct ABOS, Oc'Via and Biositiv launched in 2007 a call for proposals. An *ad hoc* consortium was then formed in response to this tender that consists of the Conservatory of Natural Areas, an ecological association specialized in land management of natural sites, the Ornithological Centre of the Gard, an ecological association specialized in the study and protection of bird species, and the Chamber of Agriculture of the Gard, a farmers' institution at the departmental level strongly involves in the technical and administrative support to farmers. This consortium was then in charge of conducting, implementing and controlling ABOS under the supervision of Biositiv and Oc'Via (see figure 15).

The main ecological objectives of ABOS are to increase food resources and create favourable habitats for little bustards. Accompanied by a team of researchers specialized in studying agri-environmental schemes for little bustards (the national scientific research centre of Chizé), the consortium defined and proposed a catalogue of 11 agri-environmental measures to implement ABOS. Technical specifications are associated to each agri-environmental measure (e.g. adapting mowing schedule during reproductive seasons or maintaining post-harvest stubble). Each measure has a fixed per-hectare payment defined on the basis of existing agri-environmental schemes (AES) framed under the European CAP that have similar objectives when they existed, or if not, on a calculation of average income foregone and additional costs tied to the implementation of the contract. Thus, payments of the environmental service are not negotiated between the parties to the transaction, i.e. the buyer (Oc'via) and the seller (the farmer). Indeed, the environmental administration, in collaboration with the Chamber of Agriculture, adopted this rule in order to avoid "competition" between AES and ABOS as well as between ABOS proposed to farmers for other offsetting projects.

In 2010, the consortium offered farmers to participate in ABOS by sending a letter to 1100 landowners. 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 enroll in the program, and the measures they proposed to apply among the 11 agri-environmental measures. 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 then set out a selection process to select the best plots to involve in ABOS based on three main criteria: the CUs gain, the cost of the measure and the ecological rating provided by plots. The ecological rating is a 1 to 4 score based on the geographic location of plots (area where little bustards have a strong presence), the plot size ("bigger is better") and the surrounding landscape (e.g. presence of hedges and nearby roads). There was no clear and precise rule to select plots regarding these three 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 corresponding to 1160 ha and contracted 100 farmers.

3.1.5. Description of ABOS contracts

ABOS contracts have a five-year duration. Each plot enrolled in the program has to follow technical specifications specified in the associated measures. Payments are given to farmers each year according to the standard payment levels defined by measure. The consortium set up a three-years monitoring and control plan of plots in which they are controlled without preliminary notice only 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 others.

Compared to classic AES contracts, ABOS contracts are therefore more flexible on both eligibility criteria and the monitoring and sanction system.

3.2. Data collection and analysis

The empirical study aims both at analysing farmers' acceptability and the effectiveness of ABOS implemented for the BO programme of the CNM project. The methodology used to analyse these two topics is presented separately in this section.

3.2.1. Farmers acceptability of ABOS

The issue of the acceptability of ABOS was analyzed through a survey carried out in early 2015. We present below the survey design as well as the methodology used for data analysis.

- **Survey design**

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.

Questions included were chosen based on factors that are considered to have an effect on the adoption of AES in the literature (Cf. Appendix 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. For example; for contract flexibility, farmers had to decide whether they "strongly disagree", "disagree", "agree" or "strongly agree" with the statement "It is easy to disengage from ABOS". Farmers also had the possibility to declare that they "do not know" the answer. 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 2.

The questionnaire was designed in discussion with the main implementing partners. 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 Chambre d'Agriculture du Gard 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. Responding to the questionnaire indeed required a minimum knowledge on ABOS. Despite the fact that all farmers had been theoretically informed once in 2010, a number of them lacked the required information to be able to properly fill the questionnaire. We therefore have 121 questionnaires that can be exploited among which 40 farmers adopted the contract (henceforth referred as adopters) and 81 did not (henceforth referred as non-adopters).

- **Data analysis**

In this survey, two variables can be analyzed: the actual decision to adopt an ABOS and the intention to adopt in coming years. The decision to adopt an ABOS was taken for many farmers several years ago (in 2010). 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 that we considered to present less endogeneity issues. The intention to perform a behavior is considered as one of the main predictor 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. 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". This variable however suffers from the limitations and biases of all stated preferences methodologies.

In this study, the 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.

We define a latent variable y^*, which is unobservable and defined by :

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

where X is a vector of variables that are considered to explain the intention to adopt an ABOS.

The intention y takes the value j if the latent variable is comprised between 2 thresholds:

$$y = j \text{ if } \alpha_{j-1} < y^* \leq \alpha_j$$

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 (j-1) intercepts (3 in our case). The underlying ordered logistic assumption is that the relationship between each pair of outcome groups is the same. This is called the proportional odds assumption or the parallel regression assumption. An approximate likelihood-ratio test will be performed in order to verify that this assumption is verified. The description of the explanatory variables used to predict the intention to adopt is provided in Table 5.

Variable	Description	Unit
Farmers and farm socio-economic characteristics		
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	NEWACTIVITY=1 (0 otherwise)
	Activity decrease or retirement close	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
Contract flexibility		
FLEX	Flexibility perception index: sum of replies to:	Continuous: sum of variables below
	The diversity of measures is an advantage	1=Agree; 0=Disagree or no opinion
	There are a lot of control	1=Disagree; 0=Agree or no opinion
	Sanctions are reasonable	1=Agree; 0=Disagree or no opinion
	It is possible to renegotiate the contract	1=Agree; 0=Disagree or no opinion
	It is easy to disengage	1=Agree; 0=Disagree or no opinion
Transaction costs		
TC	Transaction costs perception index	Continuous: sum of variables below
	There is a need to invest in equipment	1=Agree; 0=Disagree or no opinion
	Requires a large amount of time for administrative procedures	1=Agree; 0=Disagree or no opinion
	Rules and requirements are easy to understand	1=Disagree; 0=Agree or no opinion
	There is a need of a third person for implementation	1=Agree; 0=Disagree or no opinion
Intensity of change		
EASE	Ease to change perception index. The proposed measures are:	Continuous: sum of variables below
	easy to implement on my farm	1=Agree; 0=Disagree or no opinion
	fit well in my farming system	1=Agree; 0=Disagree or no opinion
	an opportunity to exploit unused fields	1=Agree; 0=Disagree or no opinion
	...an opportunity to be supported for practices I had already adopted or planned to adopt	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

Table 5. Description of the variables used in the econometric model.

- **Sample description**

Descriptive statistics of our sample are provided in table 6. Compared to farmers of the Gard province, the sample presents a number of peculiarities. 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 Province. 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 have partially biased our 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	Freq.	% of the 121 respondents	Reference (%)	Variable	Modality	Freq.	% of the 121 respondents	Reference
Gender	Male	99	81.8	73.8	**Main farm activity**	Field crops	16	13.6	4.5
	Female	22	18.2	26.2		Horticulture	10	8.6	10.9
Age	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
Farm size	Less than 20 ha	38	31.4	67.5	**Education**	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					
Importance of farming activity	Principal	100	84.8		**Organic agriculture**	Yes	26	21.5	12
	Secondary	17	14.4			No	95	78.5	88
	Retired	1	0.9						

Table 6. Descriptive statistics of the survey sample (Reference: General Agriculture Census Agreste 2010).

3.2.2. Analysis of ABOS effectiveness

In order to evaluate the effectiveness of ABOS, we analyze the different challenges highlighted in the theoretical framework: compliance, additionality, link between land use and environmental outcomes and permanence. The issues of additionality and permanence are addressed through a specific section for enrolled farmers in the farmers' questionnaire described in the previous section. Questions mainly deal 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 qualitative challenges related to the programme effectiveness. Elements of permanence and links between land use and environmental outcomes were collected during interviews with implementing partners and in the analysis of the database they provided.

In this section, we also analyze the impact the plot selection process had on its effectiveness and on the cost of the programme. We collected data from the implementing institutions on plots that farmers volunteered to enroll. Information available on these plots are the following: precedent crop, ecological rating (see section 3.1 for details on this rating), land area offered by the farmer, measure that the farmer proposed to adopt, 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 refused before the ecological diagnosis for a diversity of reasons. As mentioned in section 3.1, these plots went through a selection process carried out by the implementing institutions using a multi-criteria approach. Using the plot selection database, we estimate how much the criteria of effectiveness and overall cost of the programme actually intervened in the plot selection process.

4. Results and Discussion

In this section, we present and discuss the results in two parts: first the determinants of farmers' acceptability of ABOS coming from the field survey, and secondly, the effectiveness of ABOS.

4.1. 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 17).

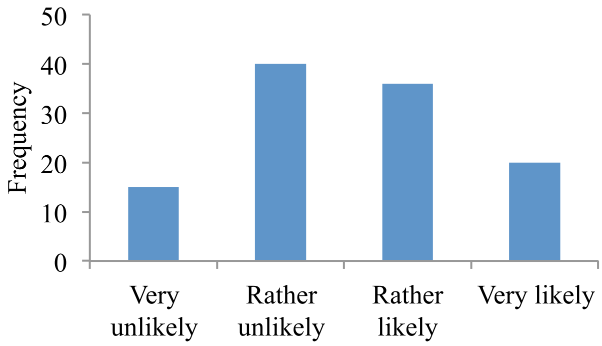

Figure 17: frequency of farmers according to their intention to adopt an ABOS in the future (Obs: 111).

The results of the ordered logit model are presented in table 7.

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

**and * refer to significance at the levels of 5% and 10%, respectively.

Table 7. Logit estimation of the intention to adopt an ABOS in the coming years.

Our 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 (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 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 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 have already enrolled in ABOS are expectedly more likely to adopt 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. Farmers that consider important the enrollment of other farmers (NORMDESC) and farmers that think that the Chambre d'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 agriculture land. Because of its size and the impact it has on local agriculture activities, it has raised oppositions from farmers' organizations and local politicians. This situation can maybe explain why perceived social norms and institutional support have an important influence on the intention to adopt. Personal attitude towards BO (ATTITBO) intervened along the same lines. Farmers that have a better general opinion of BO through agriculture activities are more likely to adopt an ABOS.

Considering that the developer is a new player in agriculture contracting and that this type of contract is new, it was anticipated that trust variables (TRUST and TRUSTDEV) would play a significant role in adoption but it does not appear to be the case.

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. The use of a more discriminating indicator of environmental susceptibility may have allowed highlighting differences. Another interpretation could that for ABOS, contrary 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. The only interpretation may be that farmers that have the most positive opinion on the results of the programme may consider their future participation superfluous.

This analysis of the determinants of the intention to participate in ABOS therefore highlights the role of traditional factors: 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. Other factors that are different in ABOS than in AES were expected to have an influence such as the perception of the flexibility of the contracts and of transaction costs but these factors do not seem to be significant. As expected, behavioral factors such as the perception of social norm and the personal attitude towards BO 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.

4.2. Effectiveness of ABOS

Results on the effectiveness of ABOS are presented through the lens of additionality and compliance, link between land use change and ecological gains and permanence. We also describe implications of the plot selection process on effectiveness and programme cost.

4.2.1. 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 figure 18.

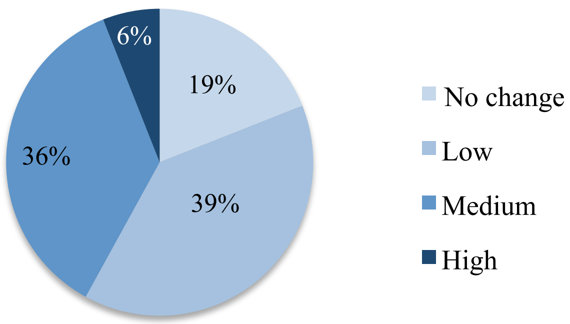

Figure 18. Intensity of practice change following ABOS adoption. (N=36)

This graph reveals that 58% of the enrolled farmers declare that they have made no changes (19%) or low modifications (39%) to their practices following the adoption of the ABOS. These figures can shed some doubts on the real additional effects brought by this programme. 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). A control made by the implementing institutions in 2013 (CEN-LR et al., 2013) indicated only 75% of conformity with the requirements of the ABOS, including 10% of unvoluntary technical difficulties and 15% of deliberate non-compliance. These results are confirmed by the responses to the question "how did you select the plot that you submitted for enrollment" are presented in table 8.

Farmers' plot selection criteria	% of respondents
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 8. Criteria quoted by farmers for farmers for the selection of plots they offered

They tend to confirm that a high rate of farmers did not implement much change in their plots. Indeed 78% of the adopting farmers indicate that they were already implementing the required practices on the plots they enrolled. Although qualitative, these results confirm that additionality and compliance issues that we theoretically emphasized in section 2 are indeed challenges for the use of ABOS to achieve BO objectives. Considering that developers should attain a mandatory outcome of ecological gains in order to achieve the "no net loss" objectives, these challenges should be addressed in future ABOS programmes.

4.2.2. Link between land use change and the provision of ecological gains

It is premature to fully evaluate the actual ecological gains linked to ABOS in our case study. 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 provoked by the the CNM project. Population surveys are being undertaken but it is too early to be able to draw conclusions yet. Our analysis on this aspect therefore rather deals with the relevance of the metric system used, compensation units or CU, to ensure that BO objectives are attained.

As mentioned in section 3.1, during the legal approval process of this development project, Oc'Via was supposed to attain an objective of 3079 CU by April 2015. This objective was attained with 512 ha of land directly acquired by the developer (1015 CU + 500 CU of bonus for the attainment of a target of 500 ha of acquisition) and 1168 ha under ABOS (1550 UC). In that perspective, the programme was designed and implemented in an effective way that led to the attainment of the legal objectives imposed to the developer.

The attainment of these objectives in terms of CU however does not guarantee the attainment of ecological objectives. As mentioned before, gains in CU are broadly calculated based on the technical prescriptions included in the ABOS and on the precedent crop present on the enrolled land. Numerous local factors can intervene in the actual ecological benefits brought by the adoption of favorable practice in a plot: 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. Considering the broad definition of CU, the ecological rating described in section 3.1 was used to evaluate the ecological interest of each plot that farmers volunteered to enroll. This ecological rating can be considered a more refined and localized evaluation of the ecological favorability of a given plot of land, if the plot would be enrolled. The analysis of the plot selection database demonstrates the loose relationship between CU and ecological rating (Table 9).

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

Table 9. Average UC/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, and therefore the possibility to reach a no net loss of biodiversity. 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 local level.

4.2.3. 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 again a contract after the end of their current contract, and 2) what they plan to do in case their current contract ends and is not renewed (Figure 19). The first criterion provides information on the durability of ecological gains over the term of the developers' commitments, and the second criterion gives information on the sustainability beyond commitments.

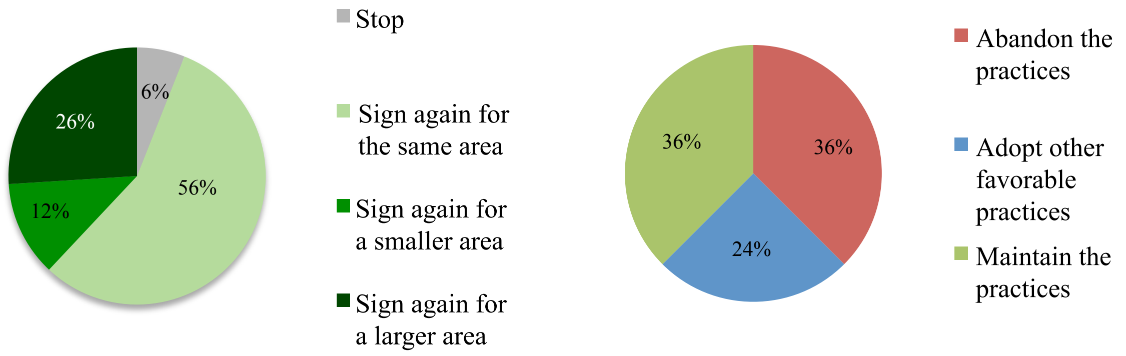

Figure 19. Farmers intentions after their current contract ends regarding the signature of a new contract (N=34) (on the left graph), and regarding their agricultural practices in the absence of ABOS (N=33) (on the right graph).

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. Maintaining farmers under contract, during the period in which the developer will keep on implementing ABOS does not seem to be a critical issue in our case study. 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.

4.2.4. Analysis of the plot selection process

As mentioned in section 3.1.4, when the developer launched the ABOS in 2011, the amount of land that farmers volunteered to enroll was superior to the programme's target. Considering that there was a greater offer of plots than the demand from the developer, the selection of plots/farmers could have been made based on an auction mechanism, such as an agri-environmental auction (e.g. Latacz-Lohmann and Van der Hamsvoort, 1997). However, for political reasons, a fixed price payments was chosen and plots were selected based on a multicriteria approach that included effectiveness criteria such as the ecological rating and the number of CU/Ha, as well as criteria that affect the cost of the programme for developers such as the relationship between the level of payment and the CU/ha[1]. The selection was done

[1] 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, Engel et Pagiola, 2008).

by the consortium of implementing partners among which some rather supported the ecological effectiveness of the programme, others supported the interests of farmers and, the developer, the cost-effectiveness of the programme.

Our aim is therefore to analyze the result of the selection process in order to reconstruct which criteria prevailed in the final plot selection. We run 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 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 (CU). Results are presented in table 10.

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***
UC	0.261	0.0458
COSTUC	-0.002***	-0.0004***
Nb. of observations	829	
Pseudo R2	0.17	
Log Likelihood	-437.7	
LR Chi2 (5)	184.88***	
Percentage of adequate predictions	76.60%	

*** and ** refer to significance at the levels of 1% and 5%, respectively.

Table 10. Logit estimation of the plot selection choice

Results show that the different criteria actually intervened in the plot selection process. The bigger the plot offered the less chance it has to be selected. This result is surprising; considering that bigger plots are *a priori* more interesting from an ecological point of view. More expected is the fact that the ecological rating strongly intervened in the selection choice, with plots with a rate of 3 or 4 that have significantly more chance to be selected. The amount of CU that a plot yielded however does not have a significant effect on the probability to be selected. As we could have expected, it is rather the cost-effectiveness criteria, that is to say the Euro amount that needs to be spent to yield 1 CU, that had a significant effect in the plot selection: the higher this amount the less chance a plot has to be selected.

It is interesting to compare the influence that the effectiveness and the cost-effectiveness had in the selection process. 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 one, 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.

We can therefore conclude that both ecological effectiveness criteria and cost-effectiveness criteria intervened at a similar level in the plot selection process. A compromise was found among the actors that intervened in this process between the overall cost of the programme for the developer and its predicted ecological effectiveness. This result can also be illustrated by simulations of the budget that would have been required if one or the other criteria would have prevailed (for the same target of CU). The annual budget required for the payment of all ABOS is presently of 1,564 M€. If only the plots with highest ecological rating would have been chosen, the budget would have increased of 32%, while the budget would have decreased of 41% if only the cost-efficiency criteria would have been used.

This compromise can be criticized. From a purely economic standpoint, minimizing the cost of the programme should be the objective. In this case, the option of selecting plots based on the cost-effectiveness criterion, like it 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. 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.

5. Conclusion and political implications

The main objective of this article was to analyse the opportunities and challenges of the use of agri-environmental schemes in biodiversity offset policies. Compared to land acquisition, ABOS present a number of interests. First, this system may be better accepted by farmers as it reduces pressure on the land market and represents an opportunity of additional revenues. Second, the use of ABOS reduces costs of implementation 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. Nevertheless, the biodiversity regulatory framework, and in particular the "No Net Loss" principle imposes the achievement of mandatory targets of ecological gains. 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 for the issue of compliance to contract requirements and additionality. In this paper, we carry out an empirical analysis to identify the magnitude of these challenges. We analyse the case of a major BO programme for a big railway bypass currently implemented in the South of France, mainly through ABOS. Through a survey carried out with 145 farmers, we particularly study the determinants of participation to ABOS as well as elements of the effectiveness of the programme.

Our results suggest that the main determinants of acceptability are: i) the 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. The importance of norms in the acceptability of ABOS is an aspect that should be considered in the implementation of ABOS. BO is a relatively new policy that raises debates amongst farmers and local politicians. Communication campaign aiming at improving the general opinion on BO and the feeling of support by other members of the community may be an important element of success of future ABOS programmes.

The analysis of ABOS effectiveness reveals issues related to additionality. It would be interesting to undertake a quantitative impact evaluation in order to precisely quantify the magnitude of this problem. 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 three 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 and the system 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. A system with differentiated payment such as an auctioning mechanism would probably improve 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 strongly modify their practices (Ferraro, 2008).

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 sanctioning 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 that for risk neutral ones when the level of sanctions is held constant (Choe et Fraser, 1999 ; Fraser, 2002 ; Latacz-Lohmann et Webster, 1998 ; Ozanne, Hogan et Colman, 2001). 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. It would therefore be necessary to raise monitoring efforts and sanctions to ensure compliance. Another option could be to raise monitoring for groups that have the highest likelihood of non-compliance (Choe et Fraser, 1999).

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. Ecological knowledge on biodiversity conservation is still limited and 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 favourability (proximity to roads, presence of other groups of the same species, proximity of other favourable habitats), targets in terms of CU can be attained with very different levels of favourability 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 ecological damages provoked by the infrastructure will remain. Whilst it is unreasonable to expect developers to finance compensation measure *ad infinitum*, it would place a considerable burden on public finances if every offset regime were to fall back on public authorities once the private sector obligation is through. Thus the long-term financing of offsets is yet to be addressed.

Documents de Recherche parus en 2016

DR n°2016 - 01: Nicolas QUEROU, Agnes TOMINI et Christopher COSTELLO
« Spatial concessions with limited tenure»

DR n°2016 - 02: Gilles GROLLEAU, Lisette IBANEZ et Nathalie LAVOIE
« Cause-Related Marketing of Products with a Negative Externality »

DR n°2016 - 03: Nobuyuki HANAKI, Angela SUTAN et Marc WILLINGER
« The strategic environment effect in beauty contest games Externality »

DR n°2016 - 04: Salvatore Di FALCO, Brice MAGDALOU, David MASCLET, Marie Claire VILLEVAL et Marc WILLINGER
« Can transparency of information reduce embezzlement? Experimental Evidence from TanzaniaExternality »

DR n°2016 - 05: Christopher COSTELLO, Nicolas QUEROU, Agnes TOMINI
« Private eradication of mobile public bads »

DR n°2016 - 06: Selly Amal KERIM
« Mesure de la pauvreté multidimensionnelle selon l'approche par Counting : application à la Mauritanie »

DR n°2016-07 : Philippe LE COENT, Raphaele PREGET, Sophie THOYER
« Compensating environmental losses versus creating environmental gains: Implications for biodiversity offsets »

DR n°2016-08 : Karine CONSTANT, Marion DAVIN
« Environmental Policy and Growth when Environmental Awareness is Endogenous »

DR n°2016 - 09: Sylvaine LEMEILLEUR, Julie SUBERVIE, Anderson EDILSON PRESOTO, Roberta de CASTRO SOUZA, Maria Sylvia MACCHIONE SAES
« Eco-certified contract choice among coffee farmers in Brazil »

DR n°2016 - 10: Philippe Le COENT, Coralie CALVET
« Challenges of achieving biodiversity offsetting through agri-environmental schemes: evidence from an empirical study »

DOCUMENT DE RECHECHE LAMETA :

Conditions d'acceptation : http://www.lameta.univ-montp1.fr/Documents/acceptations.pdf

Contact : garnierl@supagro.inra.fr/ 04 99 61 31 21