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# How diverse are farmers' preferences for large-scale grassland ecological restoration? Evidence from a discrete choice experiment

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2 **How diverse are farmers' preferences for large-scale grassland ecological**  
3 **restoration? Evidence from a discrete choice experiment.**

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17 The authors declare no conflict of interest.

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32 **Authors' contribution**

33 Marie Asma Ben-Othmen : conceptualization, methodology, writing (review and editing),  
34 resources, data collection supervision, data analysis and investigation, funding acquisition, and  
35 project management.

1 Mariia Ostapchuk: conceptualization, methodology, data collection supervision, data analysis  
2 and investigation, writing (review and editing).

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15 *this study have all consented.*

16 *Consent for publication:* The authors declare that this is an original work that has not previously  
17 been considered for publication.

18 *Availability of data and material/ Data availability:* The datasets generated during and/or  
19 analyzed during the current study are available from the corresponding author on reasonable  
20 request

21 *Code availability* (software application or custom code): The codes generated during and/or  
22 analyzed during the current study are available from the corresponding author on reasonable  
23 request

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1 **How diverse are farmers' preferences for large-scale grassland ecological restoration**  
2 **Evidence from a discrete choice experiment**

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9 **Abstract**

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11  
12 Despite their multiple ecological benefits, semi-natural grasslands are threatened by  
13 intensification and conversion to cropland farming practices. Previous agri-environmental  
14 schemes have yet to prove successful in giving adequate incentives to farmers to engage in their  
15 restoration on a large scale. Through a discrete choice experiment conducted with 110 farmers in  
16 northeastern France, we show that participation in grassland restoration can be enhanced by  
17 introducing a conditional monetary premium contingent upon compliance with the enrolled  
18 farmland's scope and spatial distribution conditions. We also found that although farmers clearly  
19 prefer to avoid signing a grassland restoration contract, technical support is a significant contract  
20 attribute. Besides, our findings underline that small dairy farmers who seem knowledgeable  
21 about ecosystem services provided by grasslands prefer signing a collective contract that  
22 engages them with their neighbors toward achieving significant ecological outcomes of  
23 grassland restoration. We conclude with policy implications within the post-2023 CAP as well  
24 as a research perspective to improve the implementation of large-scale grassland ecological  
25 restoration measures.

26  
27 JEL Classification: Q15, Q24, Q57

28  
29 Keywords: grassland restoration, discrete choice experiment, land management, agri-  
30 environmental scheme, ecosystem services.  
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## Introduction

Semi-natural grassland is an integral part of the Western and Central European landscape (Cousins et al., 2008) and is known to be among the most species-rich European ecosystems, with many services that contribute to maintaining biodiversity. These include carbon sequestration (Ricard & Viglizzo, 2020), chemical and physical flux regulation (Eekeren et al., 2010), and pollution mitigation (Balezentiene and Kusta, 2012). Semi-natural grassland is also the most threatened ecosystem in Europe due to the increased agricultural practices intensification since the late 19<sup>th</sup> century (Kahmen & Poschlod, 2008). Indeed, their low productivity made them prone to conversion into more profitable high-input agricultural land: increased fertilization levels, regular reseeding, frequent mowing and intensive grazing, deforestation, conversion to cropland, or even complete abandonment have led to a dramatic decline in semi-natural grasslands' ecological functions including biodiversity, soil, water, and overall climate protection (Kahmen and Poschlod 2008; WallisDeVries et al., 2000). Reversing this damage is challenging as grassland may recover very slowly after being altered (Bommarco et al., 2013).

Grassland restoration and sustainable management are critical to the European Union's endeavor to meet biodiversity and climate challenges. Following the reform of the Common Agricultural Policy (CAP) in 2003, EU member states have been required to establish and enforce grassland conservation and maintenance standards at the national level. One of these standards is maintaining the ratio of land designated as permanent pasture in relation to the country's total agricultural area.<sup>1</sup> On the other hand, to receive direct payment -qualify for the cross-compliance requirements- farmers must have complied with conditionality within standards that aim at grassland preservation. Furthermore, since 1992, the CAP – within its second pillar – has been promoting Agri-Environmental Measures (AEMs), renamed Agri-Environmental and Climatic Measures (AECMs) to incentivize farmers to adopt environmentally-friendly practices, support rural development, and mitigate environmental damages (Tyllianakis & Martin-Ortega, 2021). More recently, the 2023 CAP reform prescribed the AECMs implementation within a three-layer system, including cross-compliance and eco-schemes in Pillar one. While the former makes it compulsory for farmers to respect good agri-environmental practices to be eligible for financial aid, the latter allocates 25% of the first Pillar aid to farmers who agree to respect environmental specifications. The adoption of the new AECMs is limited because they are more demanding for farmers compared to eco-schemes. Thoyer & Lécole (2023) point out that even though eco-schemes are expected to cover between 60 and 80% of the European utilized agricultural area in the next decade, the coverage rate of AECMs was only 13% in 2019. Despite successive reinforcements, particularly since 2014 with the greening of the first pillar aid, the stack of measures combining regulatory obligations and financial incentives is still struggling to convince farmers.

Agri-environmental measures targeting grassland restoration and conservation are particularly relevant in France, where agriculture is the dominant land use as it covers more than half of the country's total land area (Corine Land Cover 2012). France is also a leading producer of agricultural products in the EU, producing approximately a quarter of the EU cereals and cattle, and has been the largest whole fresh cow milk producer in the last decade (Agreste, 2020). Grassland areas have been, however, alarmingly shrinking over time. While they represented

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<sup>1</sup> land used under grasses or other herbaceous that are not included in the crop rotation of the farm for five years or longer

1 43% of the agricultural area in 1970, this ratio dropped to 36% in 1988 and only 27% in 2010  
2 (Puydarrieux & Devaux, 2013).

3  
4 Within the “French Grassland Conservation Program,” two agri-environmental schemes have  
5 specifically targeted grassland conservation: the "*Premium for the maintenance of extensive*  
6 *livestock systems*" established in 1993 and replaced in 2003 by the "*Agri-environmental Grass*  
7 *Premium*." These measures are five-year contracts that compensate farmers for extensive  
8 grassland management on their farms (box 1). In 2000, France launched a new Payments for  
9 Ecosystem Services Program as part of the National Plan for Rural Development, which  
10 included two subsidies for grassland conservation (measures 19 and 20) within the "*Sustainable*  
11 *Agriculture Scheme*." The voluntary five-year contract between a farm and the government aims  
12 to encourage farmers to take action to preserve the environment and improve production quality.  
13 These measures include subsidizing the colonization of grasslands by shrubs and trees and their  
14 extensive management through mowing. There is a major difference between this contract and  
15 previous programs aimed at preserving grasslands. Unlike previous schemes, this contract does  
16 not mandate any specialization rate for the farms. With this sustainable agriculture program,  
17 farmers who previously couldn't receive "premiums for the maintenance of extensive livestock  
18 systems" and "agri-environmental premiums" due to their small amount of grassland can now  
19 enroll. The eligibility requirements of this measure centered, however, on limiting the use of  
20 nitrogenous fertilization, prohibiting plowing or carrying out heavy works on grassland, banning  
21 chemical weed management (except for localized treatment), and maintaining all the  
22 biodiversity elements in the enrolled areas.<sup>2</sup>

23 *Insert box 1 here*

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| <b>Box 1 – Agri-environmental schemes targeting grassland conservation in France</b>           | 26 |
|  | 27 |
|  | 28 |
| <b>The Premium for the maintenance of extensive livestock systems</b>                          | 29 |
|  | 30 |
| Implemented in 1993, this scheme was a five-year contract during which farmers                 | 31 |
| committed to dedicating some of their farm plots to grassland. The payment they                | 32 |
| receive in this contract was between €35/hectare/year to €46/hectare/year and                  | 33 |
| conditional on three aspects:  | 34 |
| 1. The specialization rate (share of permanent and temporary grassland in                      | 35 |
| the total utilized agricultural area) must be higher than 75%                                  | 36 |
| 2. Livestock units' density per hectare must be maintained below 1.4 per                       | 37 |
| livestock units  | 38 |
| 3. Nitrogen use is not authorized to exceed 70 kilograms per hectare of                        | 39 |
| grassland (introduced in 1998)   | 40 |
|  | 41 |
| <b>The Agri-environmental Grass Premium</b>  | 42 |
|  | 43 |
| Implemented in 2003, the eligibility criteria for the agri-environmental grass                 | 44 |
| premium are similar to <i>the extensive livestock systems maintenance premium</i> ,            | 45 |
| with three main exemptions, depending on the department where the scheme                       | 46 |
| takes place:   | 47 |
| 1. The specialization rate can be set between 50% and 75%                                      | 48 |
| 2. Livestock units' density per hectare can be set between 1.4 and 1.8                         |    |
| <sup>2</sup> See Appendix 4 for a list of photosynthetic products and fertilizers on the plots |    |
| dedicated to grassland conservation  |    |

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5 Initially, grassland conservation schemes were designed to address two main objectives. The  
6 first was to stabilize the amount of grassland areas within the agricultural landscape and prevent  
7 the conversion of grasslands into cropland (Xiao et al., 2015). The second was to support  
8 farmers in developing sustainable grassland management practices that could contribute to  
9 farms economic and environmental performance, particularly in areas where agriculture faces  
10 decline threats (Princé & Jiguet, 2013). Although the financial compensation for agricultural  
11 yield loss resulting from complying with management conditions is offered within grassland  
12 AESs, these schemes have not successfully encouraged massive enrollment by French farmers.  
13 This picture contrasts with the overall European farmers' participation in similar schemes.  
14 Zimmermann and Britz (2016) historically document this trend in their study on European  
15 farmers' participation in AES between 2000 and 2009. The findings put forth that farmers were  
16 most likely to participate in AES aimed at managing grassland and semi-natural forage areas in  
17 the eastern part of the E.U., where payments were higher (above €300 per hectare) than in the  
18 western region, including France (where payments were under €100 per hectare). Other studies  
19 have also shown that the AES design at the farm scale, solely focusing on financial incentives to  
20 ensure farms' economic performance, has not been successful (Allaire et al., 2009; Benoit &  
21 Patsias, 2017) and is still considered to be far from being cost-effective (Chabé-Ferret & Voia,  
22 2021). This may explain French farmers limited adoption of grassland AESs and why the  
23 degradation of these areas is still an ongoing problem.

24  
25 Growing evidence indicates that grassland AESs designed at the farm level fail to prevent  
26 biodiversity loss on agricultural land (Nitsch et al., 2012). While some studies suggest that AESs  
27 emphasizing a reduction in local management intensity can contribute to biodiversity  
28 conservation (Attwood et al., 2008), others have attempted to link the implementation costs of  
29 such schemes with the biodiversity outcomes in grassland settings but failed to support this  
30 claim. For example, Zechmeister et al. (2003) have tried to correlate the subsidy amount  
31 received by Austrian farmers through AESs for grassland management with the plant species  
32 richness of those areas but found no positive relationship between subsidy amounts and  
33 botanical diversity. However, the authors have demonstrated that if plant species richness is to  
34 be preserved in these grasslands, farmers must benefit from AESs that are clearly defined at a  
35 larger scale to achieve the appropriate management objectives. Hasler et al. (2022) endorse this  
36 assertion and describe what is known to be an on-farm leakage. According to the authors,  
37 reducing environmental and climate impacts in a particular farm field might co-occur with  
38 increased environmental and climate impacts elsewhere on the farm. Thus, while a field-level  
39 analysis could be misleading, landscape-scale evaluations will likely measure the practical  
40 impacts.

41 Conservation actions designed at a large-scale or landscape scale have proven effective for many  
42 ecosystems (Myles et al., 2013). Several studies have emphasized the importance of managing  
43 geographically proximate or adjacent plots to create contiguous habitats of a critical minimum  
44 size and establish connections between patches to promote species mobility and benefit  
45 biodiversity conservation (Margules & Pressey, 2000). In this context, collective action AESs  
46 implemented to ensure the proximity of farms could not only result in more significant  
47 environmental benefits (Sutherland et al., 2012), but also bridge social capital (de Krom, 2017).  
48 Therefore, understanding the conditions under which farmers would be willing to preserve  
49 grassland at a larger scale is essential in addressing one of the critical challenges policymakers  
50 face: implementing measures that protect and enhance the ecological quality of grasslands.

51

1 This study aims to fill the gap in informative research on two key questions: (1) what conditions  
2 would prompt farmers to participate in an AES aimed at grassland restoration at a large scale,  
3 and (2) how do farms and farmers' characteristics influence their preferences for participation?  
4 Overall, the research seeks to understand better the heterogeneity of farmers' preferences and  
5 how this information can inform the design of an improved and differentiated grassland  
6 restoration AES. Additionally, the study aims to uncover why some farmers choose to maintain  
7 the status quo and to estimate farmers' willingness to accept (WTA in euro/ha/year) for different  
8 features of the grassland restoration scheme.

9 Our approach sets itself apart from prior studies as we consider both collective action contracts  
10 and a farm-scale agglomeration bonus for the land involved in the scheme. This approach could  
11 lead to more significant ecological benefits at the landscape scale resulting from grassland  
12 conservation efforts. Our study utilized a Discrete Choice Experiment (DCE.) to evaluate  
13 farmers' preferences regarding adopting grassland agri-environmental schemes in Normandy, a  
14 region in northwestern France. The contracts for grassland conservation in our experiment are  
15 based on management plans prescribed by previous agri-environmental measures within the  
16 French grassland conservation program. We aim to gain insight into the varying acceptance  
17 levels of grassland conservation contracts based on their attributes. These include but are not  
18 limited to the annual payment, the percentage of farmland dedicated to grassland restoration, the  
19 availability of free technical support and advisory services, the option to sign a collective  
20 contract, and the potential for an additional conditional bonus. This bonus is offered to farmers  
21 only if they agree to enroll in a minimum contiguous area of the farm.

22 The paper is structured as follows: It begins by providing a background on agri-environmental  
23 schemes adoptions by farmers, followed by a description of the materials and methods  
24 employed, including the Normandy case study and survey design. Results and conclusions are  
25 presented in later sections.

## 26 27 **1. Background to agri-environmental schemes adoption by farmers**

28  
29 A significant body of research indicates that farmers' participation in agri-environmental  
30 schemes is closely linked to their behavioral responses and attitudes (Cullen et al., 2020;  
31 Defrancesco et al., 2008; Wilson & Hart, 2001). Additionally, the suitability of the schemes to  
32 farmers' specific farming systems plays a crucial role in determining their participation (Coyne  
33 et al., 2021; Falconer, 2000; Lastra-Bravo et al., 2015). However, a consensus has yet to be  
34 found in the literature on this dependency's exact nature and extent (Defrancesco et al., 2008).

35 Potter & Gasson (1988) and Brotherton (1989) developed one of the earliest methodological  
36 frameworks for predicting participation in voluntary land diversion schemes aimed at converting  
37 arable land into grassland in environmentally sensitive areas in the United Kingdom. Their  
38 findings highlight two primary components that affect the participation: farmers' factors, such as  
39 their willingness and situational readiness to participate in the scheme, and schemes' factors,  
40 such as the incentives or benefits that the scheme offers and make it attractive for farmers to  
41 convert some of their lands.

42 More recently, Dessart et al. (2019) proposed an extended classification of behavioral factors  
43 affecting AESs adoption, including dispositional (e.g., environmental awareness, risk  
44 perception), social (e.g., interpersonal relationships), and cognitive (e.g., knowledge and  
45 competencies) factors. Mills et al. (2017) expanded on this idea and suggested that farmers'  
46 attitudes and motivations towards AESs should be differentiated in such a way as to facilitate the  
47 understanding of correlations between the willingness to adopt (attitudes towards both profit and  
48 environment), and the ability to adopt AESs (alignment with the economic characteristics of the  
49 farm). These considerations have triggered an interest in identifying (1) the heterogeneity of  
50 farmers' characteristics, including their attitudes, motivations, and ability to engage with AESs  
51 beyond the sole profitability rationale (Cullen et al., 2020), and (2) farmers' preferences for



1 AESs through identifying parameters that enhance participation in the offered schemes  
2 (Vaissière et al., 2018).

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### 7 *Understanding farmers and farms' characteristics*

8 The literature analyzing farmers' responses to AESs has traditionally divided the factors  
9 explaining participation into two categories: internal and external (Coyne et al., 2021; Wilson,  
10 1996; Wilson & Hart, 2001). Internal factors include farmers' attitudes, beliefs, and values, as  
11 well as their socio-demographic characteristics. External factors, on the other hand, refer to the  
12 farm's geographical characteristics, size, and whether the proposed AES fits the farm  
13 management plan (see Coyne et al. (2021) for a review adapted to the context of dairy farming).  
14 Following this line of thought, Busck and Kristensen (2014) suggest distinguishing between  
15 factors and structures. According to the authors, factors such as a farm's geographical location  
16 and size should be acknowledged as fixed structures that are difficult to alter. Conversely,  
17 internal factors such as attitudes, motivations, and values are more conducive to active decision-  
18 making and are, therefore, more susceptible to being influenced.

19 The literature recognizes that attitudes are not a direct precursor to behavior but simply one  
20 factor heavily influenced by contextual factors, such as education, social norms, and farm  
21 history (Ahnström et al., 2009). While Hayden et al. (2021) refer to the relationships between  
22 farmers' attitudes and behavior as "farmer's mentality," Willock et al. (1999) argue that farmers'  
23 attitudes are linked to a set of goals, including job satisfaction, status, quality of life and  
24 management goals. Moreover, intrinsic motivations such as the need for achievement and  
25 altruistic reasons have been identified as specific objectives for farmers (Hansen & Greve, 2014;  
26 Öhlmér et al., 1998). In particular, the intrinsic value placed on the environment has been  
27 recognized as a crucial driver of farmers' engagement in agri-environmental measures (Bottazzi  
28 et al., 2018; Cullen et al., 2020). This indicates that environmental management has increasingly  
29 become essential to farming practices aligned with farmers' personal and business goals  
30 (Wheeler et al., 2018).

31 Research has shown that farmers' environmental attitudes are multi-dimensional in nature. For  
32 example, Reimer et al. (2012) found in their study of farmers' conservation behavior in Indiana  
33 (USA) that farmers motivated by off-farm ecological benefits and those who identified with  
34 stewardship responsibilities were likelier to adopt conservation practices. In a more recent study,  
35 Despotović et al. (2021) attempted to evaluate this multi-dimensional property by measuring a  
36 broad set of environmental attitudes and knowledge to assess an environmental awareness  
37 construct. Their findings indicated that environmental knowledge, which refers to the extent of  
38 farmers' understanding of environmental problems at various levels and their potential solutions  
39 (Bamberg & Möser, 2007), is the most significant predictor of farmers' environmental awareness  
40 construct.

41 Relationships between farmers' attitudes and behaviors have been explored within studies based  
42 on the conceptual microeconomic models grounded in the theory of planned behavior (Ajzen,  
43 1991) and derived from the theory of reasoned action (Ajzen, 1988; Ajzen & Fishbein, 1980).  
44 While the former state that behavioral performance is directly linked to the intention an  
45 individual tends to perform, the latter suggests that attitudes, social norms, and perceived  
46 behavioral control influence intentions and behaviors. Both theories have helped develop social-  
47 psychology models to explore farmers' behavior change and adoption of AESs.

1 For example, Borges & Oude Lansink (2016) provided an example of how farmers' intentions to  
2 use improved natural grassland in Brazil are mainly influenced by their perceptions of the social  
3 pressure to engage in this practice (subjective norm), followed by their perceptions about their  
4 own capability (perceived behavioral control), and finally their evaluation of the improved  
5 natural grassland use (attitude). These findings are consistent with other studies highlighting the  
6 importance of social factors, such as neighboring farm influence (Defrancesco et al., 2008) and  
7 perceived resources (Daxini et al., 2018; Senger et al., 2017) as critical drivers of participation in  
8 AESs. Siebert et al. (2006) support these observations in their review of 160 publications on  
9 farmers' attitudes toward AESs adoption in six European countries. The authors conclude that,  
10 although economic factors are essential for farmers, they are not the only determinants  
11 influencing their decision-making since cooperation within farmers' communities is also a  
12 significant factor in determining their behaviors. Interestingly, a systemic approach that includes  
13 farmers' socioeconomic characteristics and psychological factors to explain their behavior has  
14 received scarce attention in the literature. This claim is supported by Foguesatto et al. (2020)  
15 review of 63 papers on farmers' adoption of sustainable agricultural practices worldwide. The  
16 authors found that most of these studies should have considered psychological factors in  
17 modeling farmers' decision-making processes.

### 18 *Understanding farmers' preferences for AES and their attributes*

19 Apart from farmers' personal traits, participation in AESs depends on the design features of the  
20 schemes themselves. Because farms are economic entities, AES implies trade-offs between  
21 profits and the different measures proposed by the scheme, which vary in their levels of  
22 profitability. Farmers' perception of whether the financial compensation offered by the scheme  
23 allows sustaining profit maximization, risk minimization, and long-term farm viability has long  
24 been recognized as a crucial economic driver of their participation (Ducos et al., 2009;  
25 Espinosa-Goded et al., 2013). Certainly, farmers require financial compensation to cover not  
26 only their productivity losses but also transaction cost and, if possible, a risk premium  
27 (Christensen et al., 2011). This indicates that the required financial compensation also depends  
28 on other features of the AES.

29  
30 Several empirical studies have examined farmers' willingness to participate in AESs by  
31 assessing their monetary valuation of the different contract attributes using the economic  
32 concepts of willingness to accept (Espinosa-Goded et al., 2010; Villanueva et al., 2015). These  
33 studies are grounded in the theoretical framework of Lancaster Consumer Theory and the  
34 Random Utility Theory (Lancaster, 1966; McFadden, 1973), which suggest that farmers'  
35 decisions about the contracts hinge on the relative level of utility they derive from the contract's  
36 attributes.

37 Mainly, the Discrete Choice Experiment (DCE), a stated preference valuation technique using  
38 survey methods to evaluate individual preferences in hypothetical scenarios (Louvière et al.,  
39 2000), has been extensively used to model farmers' decisions regarding participation in  
40 environmentally friendly practices within a contract with public authorities (Chèze et al., 2020;  
41 Lienhoop & Brouwer, 2015; Ridier et al., 2021; Vaissière et al., 2018; Villanueva et al., 2015).  
42 By modeling farmers' choices, these studies estimate how they balance different levels of AES  
43 attributes against payment per hectare while identifying ways to enhance farmers' participation  
44 by testing different contract attributes. For example, Emery & Franks (2012) have shown that  
45 offering support to farmers as part of the contract may reduce the financial compensation  
46 required for enrolling in the contract. Other attributes tested include the area of farmland to be  
47 enrolled in the scheme (Espinosa-Goded et al., 2010), the opportunity to return to agriculture  
48 after the end of the contract (Lienhoop & Brouwer, 2015), the administrative burden  
49 (Christensen et al., 2011), and the opportunity offered by the contract to benefit from free

1 advisory services ( Espinosa-Goded et al., 2010). The DCE has also been used to explore  
 2 innovative designs of AESs, which includes offering incentives for spatial coordination of  
 3 conservation practices across farms by testing subsidies paid for conserving land units bordering  
 4 each other (i.e., agglomeration bonus)  
 5 (Parkhurst & Shogren, 2007). These studies have yielded, however, mixed results. According to  
 6 Kuhfuss et al. (2016) a collective bonus that is conditional in nature and offered in conjunction  
 7 with the standard AES payment can not only enhance participation but also shift farmers' pro-  
 8 environmental social norms, increase land enrollment (nudging effect), and lower overall  
 9 budgetary costs. On the other hand, Villanueva et al. (2015) found that collective participation in  
 10 AESs could reduce public transaction costs but may also make farmers reluctant due to  
 11 increased control by local authorities and other farmers.

12  
 13 In light of the above, in this study, we aim to analyze farmers' preferences for grassland  
 14 conservation contracts in Normandy, France.

## 16 2. Materials and Methods

### 18 2.1. Methodology

#### 20 2.1.1. Modelling farmers' decision to enroll in a grassland conservation AES

21  
 22 Farmers' decision to enroll in a grassland ecological restoration contract will result from  
 23 comparing the utility they derive from each proposed alternative. According to Lancaster's  
 24 theory (Lancaster, 1966) and the Random Utility Theory (McFadden, 1973), if we assume that  
 25 the utility depends on choices made from a G set of all alternatives, the random utility function  
 26 can be specified as follows:

$$28 U_{itn} = V_{itn} + \epsilon_{itn} \quad [1]$$

29  
 30 Where  $U_{ixn}$  is the utility for farmers  $n \in \{1, \dots, N\}$  derived from choosing alternative  $i \in$   
 31  $\{1, \dots, I\}$  within the choice question t.

32  
 33 Each attribute is linked with a utility level. The utility encompasses a deterministic component  
 34 which is the indirect utility level:  $V_{itn}$  and a stochastic component  $\epsilon_{itn}$ .

35  
 36 The indirect utility levels  $V_{ixt}$  is derived from the -K- observable contract's attributes denoted by  
 37  $X_i = (x_{i1}, \dots, x_{ik})$  in addition to a set A including the farmer' and farms' characteristics (e.g.,  
 38 attitudes, age, income, farm size, cropping systems, etc.), which are denoted by  $Y_n =$   
 39  $(Y_{n1}, \dots, Y_{nA})$ .

40 Hence, alternative  $i$  is chosen over alternative  $j$  if  $U_{itn} > U_{jtn}$ .

41  
 42 The deterministic component of the utility function can be expressed by introducing a vector  
 43 column following the linear specification as  $\beta_n = (\beta_{n1}, \dots, \beta_{k1})'$ . The coefficients quantify  
 44 the linear effect of the -K- observable attributes on utility and can be specified for each farmer  
 45 ( $n$ ).

46  
 47 We also introduce an alternative specific constant (A.S.C.) corresponding to the status quo to  
 48 capture any potential unobserved effect (omitted variables) on the utility function. Thus, we  
 49 define the dummy variable  $ASC^{s,q}$ , which takes the value 1 if the status quo alternative is  
 50 selected and 0 otherwise.

1  
2 Thus, the model is specified so that the probability of selecting alternative  $-i-$  depends on the  
3 alternative's attributes  $X_i$ , the alternative specific constant  $ASC^{SQ}$  of the status quo alternative,  
4 and farmers' and farms' characteristics  $Y_n$ . Since the indirect utility function  $V_{itn}$  is considered to  
5 be additive, equation [1] becomes:  
6

$$7 \quad U_{itn} = (\mu + Y_n ASC^{SQ})SQ + X_i(ASC_i^{SQ}, \dots, ASC_A^{SQ})' + \epsilon_{itn} [2]$$

8  
9 The column vector of the coefficient  $ASC^{SQ} = (ASC_i^{SQ}, \dots, ASC_A^{SQ})'$  captures the effects of  
10 farmers' and farms' characteristics on the status quo utility.

### 11 **2.1.2. Estimating the willingness to accept grassland conservation AES**

12  
13 Farmers' willingness to accept compensation for the contract's different attributes is explored  
14 through implicit prices. These prices capture welfare measures that may translate into  
15 individuals' willingness to accept (WTA) or willingness to pay (WTP) estimates (Louvière J et  
16 al., (2002). We estimate farmers' Willingness to Accept attribute K in grassland restoration  
17 contracts.  
18

$$19 \quad WTA_k = -\frac{\beta_k}{\beta_m} [3]$$

20  
21 Where  $\beta_k$  and  $\beta_m$  are the parameters representing the attribute k and the monetary attribute  
22 (payment), respectively.

23 Individual WTA of farmers ( $i$ ) for each attribute k is es estimated as follows:  
24

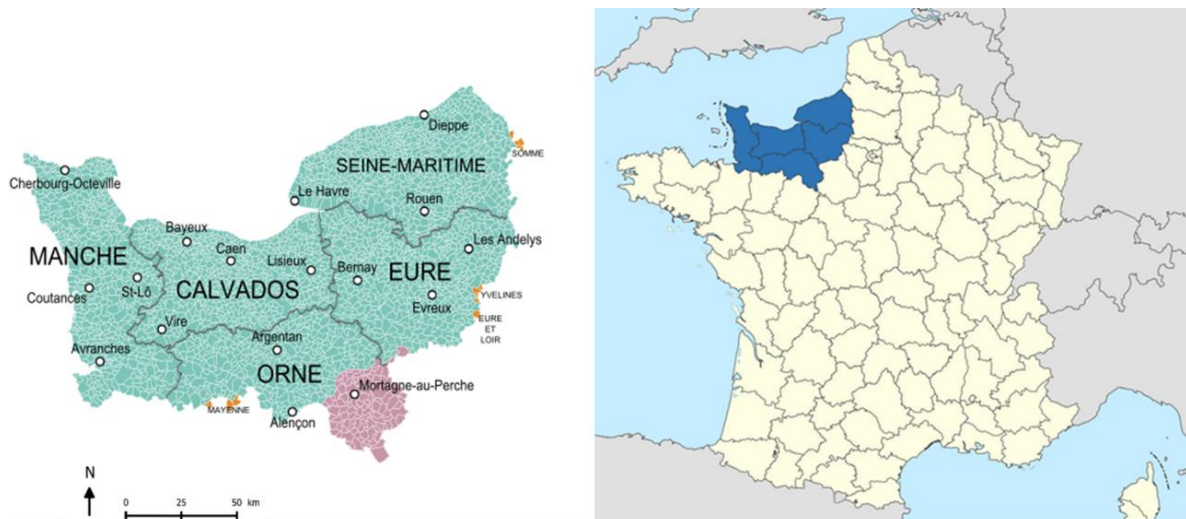
$$25 \quad WTA_{ki} = -\frac{\beta_{ki}}{\beta_m} [4]$$

## 26 27 28 **2.2. The Normandy case study and survey design**

29  
30 Normandy is considered the top agricultural region in France, as 70% of its land is used for  
31 farming (Puydarrieux & Devaux, 2013). The region has a long history of incorporating grassland  
32 into its agricultural landscape, which has resulted in the production of unique cheeses and high-  
33 quality milk from cows that are fed on grass (known as terroir). Additionally, most farms in  
34 Normandy have a Utilized Agricultural Area (UAA) of over 100 hectares, with the average  
35 being 73.6 hectares.  
36

37 Agriculture in Normandy derives 60% of its wealth from dairy, cereals (mainly in Eure), and  
38 livestock (mainly in Orne). In brief, agricultural practices in Lower Normandy are dominated by  
39 dairy farming, with up to 75% of agricultural activities involving dairy. This region, particularly  
40 La Manche, has the largest dairy herd in France. On the other hand, Higher-Normandy is  
41 specialized in cereals and livestock (Figure 1).

42 *Insert Figure 1 here*  
43



**Figure 1.** Normandy's geographical localization

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Even though permanent grassland represented 47% of the UAA in 2016, this share decreased to reach 38% in 2020 in favor of arable lands that have progressed, particularly for the cultivation of cereals and oilseeds (Agreste, 2020). At the same time, the average size of groups of contiguous plots used for permanent grassland, which was less than 6 hectares in 2016, has been continuously decreasing, resulting in a growing gap between land use and livestock production. This trend poses a significant threat to local biodiversity, as Huyghe (2005) noted. Moreover, in the last decade, French authorities have enforced more stringent regulations on farms in Normandy, restricting the number of permits to convert grassland to cropland (Ben-Othmen & Ostapchuk, 2019). These regulations follow the collective ratio of permanent grassland areas specified in the Pillar 1 mandatory green payment. However, this rigid authorization system has proved to be challenging for both farmers and authorities, as it further restricts the already limited bureaucratic process and complicates policy implementation while imposing strict regulations on farmers.

Within this study, we worked with three Normandy local authorities (Orne, Calvados, and Seine-Maritime) to design and test new incentives to improve farmers' adoption of grassland ecological restoration. A shared interest emerged between participants in designing new contracts supporting the already existing farm-based management approach to grassland restoration.<sup>3</sup> The overarching goal was to maintain a voluntary approach to adopting grassland restoration while overcoming the challenges associated with conversion authorization regimes and advocating for the various ecological benefits that large-scale grassland restoration can provide. As a result, we were tasked with providing insights into the diverse range of preferences among farmers and recommending contract attributes that would best suit Normandy's farmers and their farming practices.

In addition to the contract attributes, the questionnaire aimed to elicit farmers' environmental awareness and knowledge about the ecosystem services of semi-natural grassland. Hence, farmers were asked to state, on a rating scale, their agreement or disagreement with several statements. We used items and scales that have demonstrated success in previous empirical studies of environmental attitudes in agriculture, such as those conducted by Siebert et al. (2010) and Vogel (1996).

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<sup>3</sup> A description of the farm-based management plan presented to farmers during the survey is available in annex 1

1 Three focus groups with farmers (between 8 and 10) were conducted between February and  
2 September 2018 and helped determine the attributes and levels of grassland conservation  
3 contracts and prepare follow-up questions for the survey. The questionnaire was then pre-tested  
4 with ten farmers from Orne, Calvados, and Seine-Maritime departments and adjusted  
5 consequently.<sup>4</sup> Factor analysis was also used within the pre-test of the attitudinal questions to  
6 prepare them for the final questionnaire.<sup>5</sup>

7  
8 To ensure that farmers answered as truthfully as possible, we have had to deal with potential  
9 biases, such as the social desirability bias – resulting from respondents conforming to the social  
10 norm -. Hence, respondents were informed that the survey was entirely anonymous (Hoffman et  
11 al., 1996; Larson, 2019). Furthermore, we followed Cummings and Taylor (1999)  
12 recommendations to reduce the potential hypothetical bias by including a cheap talk script in the  
13 questionnaire.

14  
15 The final version of the questionnaire included five sets of questions. (1) structural  
16 characteristics of the farm (used agricultural area, economic and technical orientation), (2)  
17 farmers' characteristics (gender, age, off-farm income, education), (3) information about the  
18 agricultural practices (soil management, stoking rates, the yield obtained) (4) choice set and  
19 follow up questions (as described in sections 2.2.1, 2.2.2. and 2.2.3), and (5) farmers' attitudes  
20 towards the environment and their knowledge about grasslands multiple ecosystem services. The  
21 questionnaire required 20 minutes to be completed. Thanks to a list of contacts provided by local  
22 farmer union bodies (Chambre d'Agriculture), 1310 farmers were contacted, informed about the  
23 study's goals, and asked if they would accept participating in the survey by arranging face-to-  
24 face meetings on their farms' sites from February through September 2019.

### 25 26 **2.2.1. Grassland restoration contracts attributes description**

27  
28 As previously stated, within this study, we deploy the discrete choice experiment framework to  
29 create a survey setting where farmers are requested to choose their preferred grassland  
30 conservation contract from two hypothetical contracts. Still, if none of the contracts fits their  
31 expectations, they can keep their current practices by selecting the status quo option. Each time,  
32 three alternative contracts, described in choice cards, were successively submitted to farmers  
33 who were requested to state their preferred contract.

34  
35 The terms and conditions of the contract were first presented to the farmer. These are as follows  
36 1. The grassland conservation contract is additional to regulatory obligations; it could not  
37 replace existing cross-compliance requirements within the CAP, 2. Farmers must agree to allow  
38 access to their farmland for ecological monitoring and compliance control by local authorities, 3.  
39 For five years, there is no right to withdraw from the contract.

40  
41 Grassland conservation contracts have five attributes as described in Table 1. The first attribute  
42 is the *Land Enrollment Ratio*. Ecologists suggest that permanent grassland promotes habitats  
43 with rich biological values and high species richness depending on a specific minimum area  
44 covered by the grass on the farmland and how it is managed by the farmer to ensure viability

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<sup>4</sup> In summer 2018, we attended and shared information about the goal of our study during the annual forum *Prairiales Normandie 2018*, the largest annual gathering of Normandy and France's great west practitioners and professionals sharing a typical interest in grassland and fodder production. This gathering has also offered opportunities to start the conversation with farmers about their opinion regarding new grassland ecological restoration contracts and collect contacts <http://www.prairiales-normandie.fr/>

<sup>5</sup> Final questions are available in annex 2

1 (Waldén & Lindborg, 2018). Hence, three levels of land enrollment were presented to farmers:  
 2 (1) the farmer chooses to enroll at least 5% - which is like other "greening" contracts  
 3 requirements that he (or she) would experience in a "real-life" context - (2) 10% or (3) 15% of  
 4 his (or her) farmland in grassland ecological restoration.

5 The second attribute is the availability of *Free Technical Support and Advisory Services*. This  
 6 attribute has emerged from the focus group consultation as a requirement that farmers could  
 7 consider necessary as they were interested in getting additional knowledge about  
 8 environmentally friendly techniques to enhance ecosystem services from extensive grassland  
 9 management. Hence, the two levels of this attribute are "available" or "not available" in the  
 10 scenario.

11  
 12 The third attribute is a *Premium*, a conditional monetary bonus associated with the farmer's  
 13 commitment to achieving additional ecologically sound conditions suggested in the scenarios he  
 14 (or she) can accept or not. Accordingly, the farmer is requested to enroll at least 4ha of his  
 15 farmland in grassland ecological restoration that must be included on the same parcel (e.g., in  
 16 one piece); hence, accepting the *Premium* implies the farmer getting €250/ha/year payment in  
 17 addition to the baseline payment. In the scenario, the two levels of this attribute are "available"  
 18 or "not available."

19  
 20 The fourth attribute, *Collective participation*, sought to investigate farmers' willingness to  
 21 participate in a landscape-scale grassland conservation effort by ensuring in the contract that the  
 22 farms' proximity and farmers' collaboration contribute to significant ecological outcomes  
 23 derived from the grassland conservation (Sutherland et al., 2012). Hence, the attribute included  
 24 two levels. 1) *Collective Action Contract* requires that the farmer work closely with at least three  
 25 of his neighbors in cross-farm boundary and perform collective actions to ensure better  
 26 outcomes from grassland restoration. 2) *The Individual Contract* requires the farmer to enroll in  
 27 a contract without any obligation of collective action with the neighboring farmers.

28  
 29 The fifth attribute is the *Financial Compensation* of €130/ha/year, €230/ha/year, or  
 30 €330/ha/year. The current payments for agri-environmental schemes in Normandy have guided  
 31 the choice of €130/ha/year as a lower limit<sup>6</sup>. The scope of these levels has been discussed and  
 32 approved during the focus group meetings.

33  
 34 ***Insert Table 1 here***

35  
 36 **Table 1.** Attributes' description, levels, and their coding to characterize grassland  
 37 ecological restoration contracts submitted to farmers  
 38

| Contract's attributes | Description   | Levels                                | Coding           |
|-----------------------|---|---------------------------------------|------------------|
| Land Enrollment       | The percentage of farmland to be enrolled by the farmer in grassland restoration  | 5%,<br>10%,<br>15%,<br>Opt-out        | 1<br>2<br>3<br>0 |
| Technical support     | Technical support and advisory services for farmers about best management practices of farming systems using permanent grassland. | Available<br>Not available<br>Opt-out | 1<br>-1<br>0     |
| <i>Premium</i>        | Farmers are requested to enroll at  | Available                             | 1                |

<sup>6</sup> The two other levels are like the current AESs compensations for temporary pasture and fields vegetable crops, respectively.

|                          |  |  |                        |
|--------------------------|--|--|------------------------|
|                          | least 4 ha of their farmland in grassland conservation. These must be located on the same parcel (e.g., in one piece) to benefit from €250/ha/year in addition to the yearly (baseline) payment. | Not available in the contract<br>No premium because this is the opt-out response | -1<br>0                |
| Collective participation | Farmers' collective participation is the participation of at least three farmers in a contract involving collaboration between them  | Collective contract<br>Individual contract<br>Opt-out                            | 1<br>-1<br>0           |
| Financial compensation   | Payment received annually by the farmer per enrolled hectare   | €130/ha/year<br>€230/ha/year<br>€330/ha/year<br>Opt-out                          | 130<br>230<br>330<br>0 |
| Opt-out (status quo)     | The farmer prefers to keep his/her current practices   | Opt-out<br>Grassland contract 1 or 2   | 1<br>0                 |

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2

### 3 2.2.2. The discrete choice experiment

4

5 To assess and understand the relative importance of each attribute of the contract for farmers, we  
6 combined their levels into scenarios intended to describe different grassland conservation  
7 contracts. Since we have five attributes with 2 to 3 levels each and two choice cards, the  
8 complete factorial design generates 5112<sup>7</sup> different choice cards. Following the questionnaire  
9 pre-test, the OPTEX procedure in S.A.S. was used to search for optimal experimental design  
10 (Street et al., 2005) and led to ten combinations.

11 The combinations were then organized in pairs, generating five choice cards. To each choice  
12 card, an opt-out answer declaring "*I prefer to keep my current agricultural practices*" and  
13 referring to the *status quo* was added (Figure 2).

14

15 More specifically, performing a two-step procedure led to the five-choice cards. Firstly, an  
16 orthogonal efficient design with all the initial parameters set to zero was performed using the  
17 dedicated software (*Ngene*) to determine the specific previous parameters of the sample and to  
18 choose the pre-test study choice cards. The obtained D-error was 0.021019 was judged  
19 appropriate. Then, a Multinomial Logit Model was applied to analyze the pre-test study data to  
20 understand better each attribute's prior parameters' values. Secondly, a Bayesian efficient design  
21 using the pre-test study parameters was performed and helped make the final study cards choice  
22 (using *Ngene* software) (Chaloner & Verdinelli, 1995).

23

24 In order to avoid any confusion with the opt-out (status quo) answer and following the literature  
25 (Bech & Gyrd-Hansen, 2005; Vaissière et al., 2018), we opted for effects coding rather than  
26 dummy coding for the *Premium*, *Technical Support*, and *Collective Participation* variables.  
27 Their presence in the grassland conservation contract is coded 1. In contrast, the opt-out  
28 alternative has, by definition, no premium, no technical support, and no collective participation







<sup>7</sup> The full factorial design generates  $(3 \times 2 \times 2 \times 2 \times 3) \times ((3 \times 2 \times 2 \times 2 \times 3) - 1) = 5112$  choice cards.



1 and thus coded zero. The absence of *Premium*, *Collective Participation*, and *Technical Support*  
 2 in a contract is coded -1<sup>8</sup>.

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*Insert Figure 2 here*

|   | Alternative A   | Alternative B  |  |
|---|---|--|--|
| Land to be enrolled in the contract   |  |  | I prefer to maintain my current farming practices (Status Quo) |
| Collective participation  |  |  |  |
| Availability of free technical assistance and advisory service              |  |  |  |
| Premium (€250/ha/year ecological Bonus for enrolling 4 ha on the same plot) |  |  |  |
| Financial Compensation  | 130 €/hectar/year   | 230€/hectar/year   |  |
|   | <input type="checkbox"/>  | <input type="checkbox"/>   | <input type="checkbox"/>                                       |

6  
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**Figure 2 – Example of the choice sets**

8 **2.2.3. Follow-up questions**

9

10 Follow-up questions asked at the end of the presentation of the scenarios to farmers were drawn  
 11 with the help of the focus group participants. These questions helped confirm the quality of the  
 12 responses to the choice experiment and improved the interpretation of the results.

13 Hence protest answers were screened and eliminated from the analyzed sample. This has  
 14 concerned farmers who answered no to the question: “*Did the survey's questions and the choice*  
 15 *cards seem clear to you?*” and those farmers who systematically refused to choose any contract  
 16 without trying to understand their arrangements. According to Barrio & Loureiro (2013), such  
 17 answers do not add useful information on contract attribute preferences. We have also removed  
 18 all the responses from farmers who answered that the primary reason for their opt-out was that  
 19 (a) she or he thinks that biodiversity conservation is inconsistent with agricultural activities, and  
 20 (b) she or he was against agri-environmental schemes in general or those who answered that (c)  
 21 non-withdrawal from the contract is intolerable. These reasons were presented to farmers who  
 22 have chosen the opt-out answer systematically or at least once<sup>9</sup>. However, farmers who gave  
 23 attention to the scenario description compared the five choice sets during the survey and  
 24 systematically selected the opt-out option remained in the final sample.

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 27

**3. Results**

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<sup>8</sup> As suggested by (Haaijer et al., 2001) in their paper: “*the no-choice alternative in the conjoint choice experiment*,” an additional variable was employed for the opt-out option. This takes the value of 1 if the farmer chooses to keep his current farming practices, with the five attributes of the grassland conservation contract taking the value of 0.

<sup>9</sup> The other suggested answers were: “I prefer my current land use plan,” “I did not like any of the contracts,” “the contract is not feasible on my farm,” “the payment is not enough,” and “no answer.”

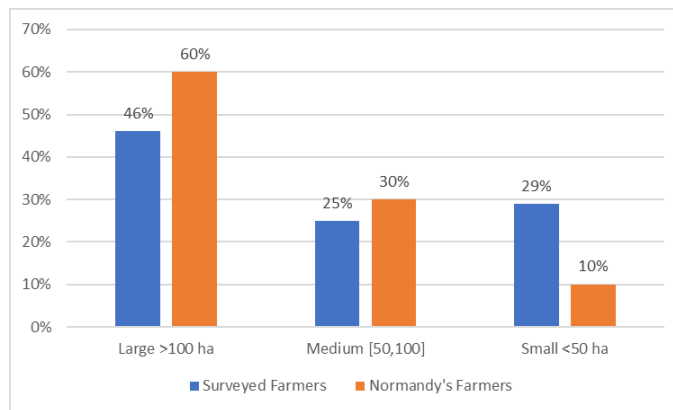
1 **3.1. Sample characteristics**

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3 From the final 120 completed questionnaires, protest answers were removed from the final  
4 sample (ten questionnaires), resulting in a sample size of 110 farmers.

5 Table 2 presents the descriptive statistics of the final sample composed of 110 usable responses.  
6 The respondents' ages range from 36 to 64 years, with an average of 49 years. The average used  
7 agricultural area is 98 hectares of agricultural utilized area<sup>10</sup>. Figure 3 visually represents the  
8 sample farms' size distribution compared to the regional level. The representativeness of mid-  
9 sized and large farms is good; however, we observed an over-representation of small farms.

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11

**Figure 3 - Farms sample versus Normandy's farms' size**



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14 In our sample, on average, farmers dedicate 72 hectares to crops for sale purposes. The average  
15 area dedicated to permanent grassland is about 22 hectares (which represents 23% of agricultural  
16 land). There is, however, a significant variability among farms revealed by the standard  
17 deviation (32.1), which can be explained by the discrepancies between farmers' agricultural  
18 practices that have historically characterized the grassland-cropland conversion in Normandy.  
19 31% of respondents are dairy farmers, which is substantially above the national average (14%)  
20 and consistent with the regional ratio (29%), as shown in Figure 4. The representativeness of  
21 livestock mixed-crops farms is also good as it is consistent with the regional ratio.

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*Insert Table 2 here*

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<sup>10</sup> The mean age is below the average for French farmers which is 52-year-old.

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**Table 2.** Sample descriptive statistics

| <b>Variables</b>   | <b>Mean</b> | <b>Standard Deviation</b> | <b>Min</b> | <b>Max</b> | <b>Explanation</b>   |
|--|-------------|---------------------------|------------|------------|--|
| Age  | 45.41       | 25.25                     | 32         | 69         | Farmer's age in years  |
| U.A.A.   | 98          | 83.445                    | 27         | 307        | Utilized Agricultural Area in hectares   |
| P.G. share (%)   | 0.23        | 0.321                     | 0.03       | 1          | Share of permanent grassland in U.A.A.   |
| Maincrop share (%)   | 0.65        | 0.2925                    | 0.17       | 1          | Share of the dominant crop in arable rotation  |
| Livestock units  | 1.05        | 0.632                     | 0.5        | 1.9        | Livestock Units per hectare (1 L.U. = 500 live weight)   |
| Dairy*   | 0.31        | 0.522                     | 0          | 1          | Farmers with on-farm dairy production  |
| Dairy stoking rate   | 0.80        | 0.5225                    | 0.42       | 1.67       | Number of dairy cows in L.U. per hectare of U.A.A.   |
| Awareness bout the environmental impact of intensive agricultural practices ** | 0.58        | 0.222                     | 0          | 1          | Agriculture is responsible for several negative impacts on the environment that are unacceptable (5 = I fully agree) |
| Knowledge about grassland ecosystem services**                                 | 0.32        | 0.252                     | 0          | 1          | Grasslands are a rich ecosystem that provides ecosystem services (5 = I fully agree)                                 |
| External source of income*   | 0.19        | 0.242                     | 0          | 1          | Farmers who have an external source of income  |

14 Note:\*Dummy variable, \*\* Measured on a rating scale 1-5

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Insert Figure 4 here

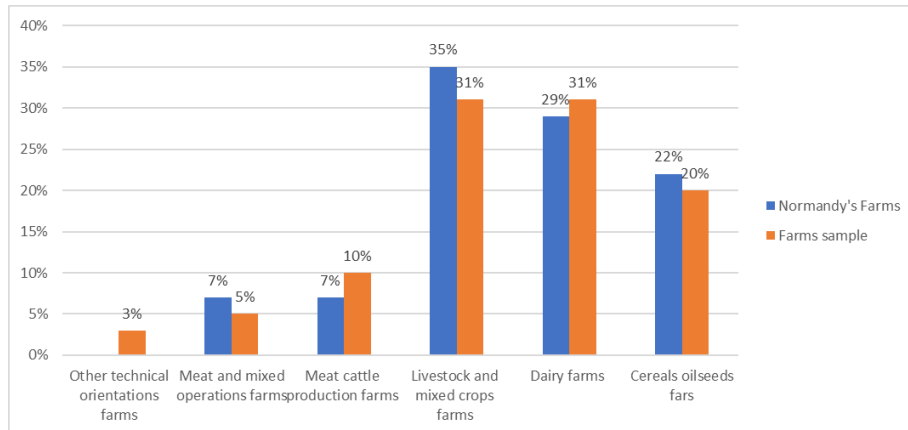


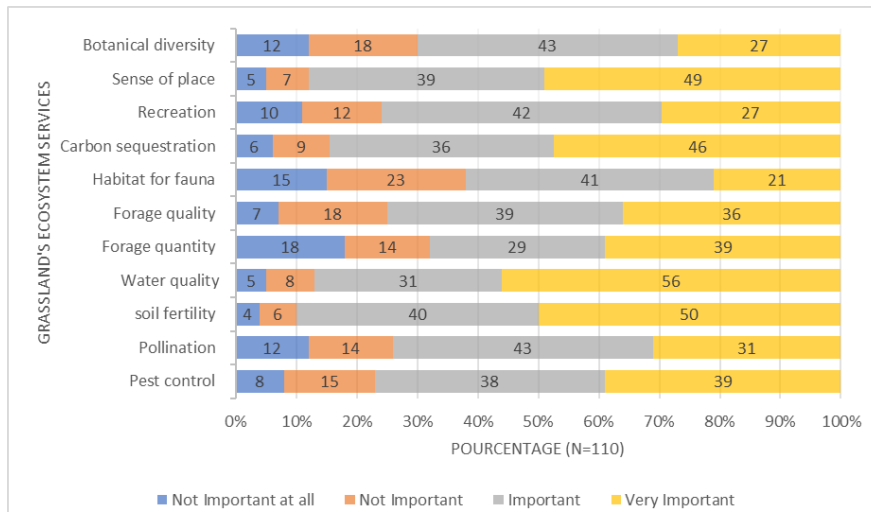
Figure 4 – Economic and technical orientations of the sample's farms versus Normandy's farmers

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76 % of respondents accepted at least one of the contracts. We may have expected that farmers who are strong advocates for grassland as they use it in their farming practices have responded disproportionately, allowing for potential self-selection into the sample. This, however, was not the case as we observed that none of the farmers accepted grassland conservation contracts in all choice cards as everyone had chosen the opt-out option at least once. 24% of respondents systematically chose the status quo option without being considered protest answers. This is because (a) they prefer to keep their current farming practices and are reluctant to change even if the contract offers a higher payment, (b) they were unsatisfied with the previous grassland AES, or (c) the grassland conservation contract is technically impossible on their farmland.

The answer to the question asked to elicit farmer's environmental concerns, "*Intensive farming practices are harmful to the environment; farmers have to adapt their practices towards sustainability*," reaches an average score of 3.3 on a ranking scale from (1 - I totally disagree to 5 - I totally agree). When asked about the value they attach to ecosystem services provided by grassland in Normandy, farmers' responses reflect that, for most of them, all the ecosystem services appear to be important. Soil quality, fertility, and grassland's contribution to creating a sense of place (cultural heritage) were considered to be very important by farmers. Similarly, the forage quantity and quality are recognized as very important by 39% and 36% of respondents, respectively (Fig 5).

Insert Figure 5 here



**Figure 5.** Farmers' perception of grassland ecosystem services benefits

### 3.2. Econometric estimation

#### 3.2.1. Farmers' decision to enroll in a grassland ecological restoration contract.

At first, farmers' decisions to enroll in a grassland conservation contract were analyzed using a conditional logit (CL) model. The comparison between the full conditional logit model and partial conditional logit model through dropping alternatives successively one by one highlights the rejection of the independence from irrelevant alternative (I.I.A.) assumption and leads to the invalidity of the CL estimations for our sample (with  $\text{Prob}>\text{Chi}^2 = 0.3127, 0.3501, 0.3712, \text{ and } 0.4366$ ).

The I.I.A. assumption was then relaxed. Farmers' decision to enroll in grassland conservation contracts was modeled with a random parameter logit model (R.P.L.), also called the mixed logit model, to analyze the data. The analysis involved two stages. First, farmers' participation was modeled according to the grassland conservation contract attributes. Second, the model was extended by including farmers' and farms' characteristics to explain the choice of the status quo (opt-out option). Since these characteristics cannot be included alone in the model (they are unvarying across one individual), they are captured through interaction variables. The models have reasonable goodness of fit with an estimated McFadden Pseudo  $R^2$  of 0.25 and 0.27, respectively.

##### 3.2.1.1. RPL. model without interaction

The estimated mean and standard deviation of the normally distributed coefficients provides information on the proportion of respondents that positively value a specific attribute and those that place a negative value. The standard deviation of most coefficients is statistically significant, confirming the accuracy of using the R.P.L. model to analyze the data.

Given the small sample size and following Chèze et al. (2020), we chose to retain the conservative value of 5% rather than 10% as a significance level to reject the null hypothesis of the student test. In this way, we attempted to reduce the probability of making a Type-I error. All attributes and levels except *Collective Participation* and *Land Enrollment* are statistically significant at this level. This is not surprising given the constraint imposed by these attributes compared to the other contract's attributes. The fact that farmers are less likely to participate in

1 contracts that require a high ratio of land enrollment compared to other contract attributes is not  
 2 unexpected. This reflects the prevailing trend of farm specialization in Normandy, where there is  
 3 a significant opportunity cost associated with enrolling land in grassland restoration contracts.  
 4

5 In our understanding, farmers are most likely to perceive collective contracts that involve  
 6 collaboration with neighboring farmers as a burden rather than a support measure. Nonetheless,  
 7 there is a persistent heterogeneity in preferences that we could not identify, as shown by the  
 8 significant standard deviations of both attributes *Collective Participation* and *Land Enrollment*.  
 9 Furthermore, the likelihood of farmers' participation increases with the availability of *Free*  
 10 *Technical Support and Advisory* and the conditional *Premium*. It also slightly increases with the  
 11 financial compensation.  
 12  
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17 *Insert Table 3 here*

**Table 3.** RPL. model estimates

| Attributes   | R.P.L. Model without interaction |                     | R.P.L. model with interaction |                     |
|--|----------------------------------|---------------------|-------------------------------|---------------------|
|  | Coefficient                      | Stand. Dev.         | Coefficient                   | Stand. Dev.         |
|  | (SE)                             | (SE)                | (SE)                          | (SE)                |
| <i>ASC_SQ</i>  | -0.766**<br>(0.283)              | 2.381***<br>(0.653) | -0.518***<br>(0.522)          | 2.715***<br>(0.699) |
| <b>Land Enrollment</b>   |                                  |                     |                               |                     |
| <b>Land Enrollment (10%)</b>   | -0.6182*<br>(0.273)              | 0.925**<br>(0.337)  | -0.971*<br>(0.201)            | 0.870*<br>(0.578)   |
| <b>Land Enrollment (15%)</b>   | -1.564*<br>(0.499)               | 1.259**<br>(0.368)  | -1.608*<br>(0.778)            | 1.144*<br>(0.614)   |
| <b>Free Technical Assistance and advisory (Yes = 1)</b>                    | 0.457***<br>(0.409)              | 0.128**<br>(0.604)  | 0.299***<br>(0.378)           | 0.121**<br>(0.562)  |
| <b>Collective Participation</b>  | -0.689*<br>(0.136)               | 1.456*<br>(0.778)   | -1.148*<br>(0.478)            | 1.983*<br>(0.341)   |
| <b>Premium</b>   | 0.219***<br>(0.067)              | 0.121**<br>(0.651)  | 0.378***<br>(0.098)           | 0.242*<br>(0.871)   |
| <b>Compensation Level (€/hectare/year)</b>                                 | 0.002***<br>(0.0009)             |                     | 0.008***<br>(0.0005)          |                     |
| • <u><i>Crossed with Land Collective Participation</i></u>                 |                                  |                     |                               |                     |
| <b>Grassland ecosystem services knowledge</b>                              |                                  |                     | 0.168***<br>(0.0061)          |                     |
| <b>U.A.A.</b>  |                                  |                     | -0.065**<br>(0.0245)          |                     |
| • <u><i>Farms and Farmers' characteristics crossed with the ASC_SQ</i></u> |                                  |                     |                               |                     |
| <b>Age (in years)</b>  |                                  |                     | 2.122***<br>(0.367)           |                     |
| <b>Environmental attitudes</b>   |                                  |                     | -0.325***<br>(0.076)          | ---                 |
| <b>Outside income (Yes = 1)</b>  |                                  |                     | -0.165***<br>(0.514)          | ---                 |

|                               |           |                      |           |
|-------------------------------|-----------|----------------------|-----------|
| <b>Dairy Stoking rate</b>     |           | 1.737***<br>(0.531)  |           |
| <b>Livestock units</b>        |           | 1.537***<br>(0.768)  |           |
|                               |           | 2.965**<br>(0.511)   | ---       |
| <b>Dairy</b>                  |           | -3.121***<br>(0.154) |           |
| <b>Number of respondents</b>  | 110       |                      | 107       |
| <b>Number of observations</b> | 2830      |                      | 2580      |
| <b>Chi<sup>2</sup></b>        | 443.66123 |                      | 398.34543 |
| <b>AIC</b>                    | 1483.0987 |                      | 1278.2098 |
| <b>BIC</b>                    | 1510.3450 |                      | 1310.4491 |

1 Standard errors in parenthesis

2 Significant levels: \*\*\*p<0.01, \*\*p<0.05, \*p<0.1

3

4 It is worth noting that the availability of the *Premium* significantly increases the probability of  
5 farmers signing a contract for 62% of the choices. They, however, could not benefit from the  
6 *Premium* if their choice of the enrolled area corresponding to 5%, 10%, or 15% is lower than  
7 4ha<sup>11</sup>. This was the case for 15% of respondents. While conducting the survey, farmers were  
8 informed that they would not receive the *Premium* if the size of the land enrolled in the contract  
9 was less than 4 ha. Nonetheless, 3% of the respondents refused to accept the *Premium* although  
10 they agreed to enroll more than 4 ha of their land. This result suggests that they disagreed with  
11 the ecological constraint imposed by this particular contract attribute.

12

13 The *Alternative Specific Constant*, corresponding to the status quo variable ( $ASC^{SQ}$ ), is  
14 statistically significant and negative. This indicates that in *ceteris paribus*, farmers negatively  
15 value maintaining the status quo and choosing not to enroll in one of the contracts presented to  
16 them. Overall, the standard deviation reveals that preferences for all the attributes are  
17 heterogenous in our sample. It is also highly significant for the  $ASC^{SQ}$  and has a positive sign,  
18 meaning that some farmers value the status quo.

19

### 20 3.2.1.2. Interactions with farmers and farms' characteristics

21

22 Heterogeneity among farmers was analyzed extensively by considering the interaction effect  
23 with additional variables, namely farmers' and farms' characteristics. We have mainly used  
24 demographic variables (age, income, availability of an outside income, education level), the  
25 structural characteristics of the farm (size, main crop share, dairy, and livestock production), and  
26 the variables reflecting farmers' environmental concerns in general, and their knowledge about  
27 the ecosystem services provided by grassland. A backward elimination procedure was applied to  
28 circumscribe the variables with the most substantial interactions with each attribute.

29 The most significant variables were then selected to estimate the interactions with the *status quo*  
30 variable ( $ASC^{SQ}$ ). The obtained results are noteworthy as they provide insights into the farmers'  
31 and farm characteristics that increase the likelihood of moving away from the status quo. The  
32 extended model's results are presented in the two right-hand columns of Table 3.

33

34 The interaction term coefficient between the *Collective Participation* attribute and the dummy  
35 variable reflecting farmers' knowledge about the ecosystem services grassland provides is  
36 statistically significant and positive at the 1% level. In other words, this result demonstrates that

<sup>11</sup> A choice card with "premium available" and "land enrollment =0" does not exist among the choice cards.

farmers who are aware of the multiple ecosystem services offered by grassland are more likely to accept collective contracts. On the other hand, in our sample, small-scale farmers are more likely to accept the collective participation option proposed in the contract. This result points to current concerns in the French agricultural landscape about those small farms increasingly facing significant constraints linked to scale, fragmentation, and resource access which are challenging to overcome (Agarwal & Dorin, 2019). We might presume that these farmers need to engage in another farming model wherein they can pool their land, labor, and capital, resulting in shared costs and benefits.

Turning to the interaction results with the  $ASC^{SQ}$  variable, the interaction coefficient of *Age* is significant and positive at the 1% level, meaning that older farmers are more likely to select the *status quo* option. This finding may be explained as a reluctance effect or a production loss risk aversion due to the considerable change the contract could imply for these farmers. Besides, the outside revenues coefficient is significant and negative at the 1% level, meaning farmers with additional income sources are more willing to enroll in a grassland restoration contract.

Although farmers' perception of whether the financial compensation fully covers the extra costs positively affects participation, farmers concerned about the adverse effects of agricultural practices on the environment are more likely to change the *status quo* option. Finally, farmers value negatively maintaining their current farming practices and not participating in grassland ecological restoration, as reflected by the statistically significant and negative  $ASC^{S.Q.}$  coefficient.

### 3.2.1.3. WTA estimation

The delta method at 95% interval was used to estimate standard deviation and the confidence intervals around the mean WTA values. Table 4 shows the WTA results calculated using the R.P.L. model and the extended version accounting for additional interaction effects with attitudinal variables (environmental awareness and knowledge about grasslands ecosystem services) that would help understand farmers' choices relative to their goals. Both models yielded similar estimates, showing that they are relatively robust.

**Insert Table 4 here**

**Table 4.** WTA and confidence intervals (euro/ha/year)

|                                 | R.P.L. Model without interaction |                              | R.P.L. model with interaction |                              |
|---------------------------------|----------------------------------|------------------------------|-------------------------------|------------------------------|
|                                 | WTA (€/ha/year)                  | Confidence Interval [95% CI] | WTA (€/ha/year)               | Confidence Interval [95% CI] |
| <i>Land Enrollment</i>          | 219                              | [150.88 ;290.98]             | 201                           | [150.36 ; 281.36]            |
| <i>Technical Assistance</i>     | -42.36                           | [-28.31 ; -91.61]            | -47.60                        | [-26.31 ; -92.31]            |
| <i>Collective Participation</i> | 80.98                            | [45.78 ; 147.31]             | 78.25                         | [36.78; 122.7]               |
| <i>Premium</i>                  | -123.48                          | [-191.41 ; -89.87]           | -128.47                       | [-189.10 ; -80.56]           |
| <i>Opt-out</i>                  | -510.01                          | [-1987 ;530.21]              | -503.98                       | [-2018.7;547.01]             |
| Environmental awareness         |                                  |                              | -6.28                         | [-4.18 ; 17.36]              |
| Environmental knowledge         |                                  |                              | -12.91                        | [5.12; 18.13]                |



1 All else being equal, farmers tend to accept higher financial compensation for contracts with  
2 collective participation that involves collaboration since they require €80/ha/year in subsidies.  
3 Moreover, farmers are prepared to forgo €123/ha/year to receive the *Premium*, although its  
4 actual value is €250/ha/year, meaning they will still derive a net benefit from it. Implementing a  
5 contract with ecological constraints - imposing to enroll at least 4ha of his farmland in grassland  
6 ecological restoration that must be included on the same parcel - will cost the regulator €127  
7 ha/year. On the other hand, farmers are willing to forgo 42€/ha for contracts that provide  
8 technical assistance and €510/ha/year to maintain their current farming practices, which means  
9 they would only participate in contracts that provide a payment higher than €510/year/ha.  
10 Compared to income obtained from other crops ranging between 750 and 2200€/ha in  
11 Normandy, the payment offered by the grassland restoration contract only amounts to  
12 €330/ha/year, and we might presume that some farmers require the contract's compensation to  
13 be as lucrative as their current land use. Finally, even if environmental awareness significantly  
14 influences farmers' WTA, those who believe that the ecosystem services provided by grassland  
15 are important to very important have a much higher expressed WTA and are willing to pay  
16 almost twice the amount compared to those who are merely concerned about environmental  
17 issues.

18  
19

#### 20 **4. Discussion and conclusion**

21

22 Grasslands provide numerous environmental benefits, such as improved product quality and  
23 enhanced animal and human health and serve as a ruminant feeding source. However, these  
24 areas face significant threats from intensification and conversion to other land uses. Despite the  
25 existence of grassland protection measures under the Grassland Conservation Program in  
26 France, these schemes have attracted only a few farms that meet the required stocking rate  
27 thresholds and have opted for extensive grazing systems. In contrast, farmers' participation is  
28 limited in areas that offer opportunities for cultivation and intensification. Additionally, these  
29 schemes only focus on farm-scale management approaches and have failed to achieve large-  
30 scale ecological benefits from grassland restoration.

31

32 Despite their potential for ecological gains through ecological restoration, farmers' preferences  
33 for large-scale approaches to grassland restoration have received little attention in the literature.  
34 These approaches rely on collaborative action and collective contracts between neighboring  
35 farmers who must formally work together to achieve landscape-oriented ecological outcomes  
36 (Prager, 2015). One may also wonder if grassland restoration contracts with restrictive  
37 conditions justified by achieving ecological performance while offering additional financial  
38 incentives (e.g., Premium) and technical support can match farmers' preferences and constraints.

39

40 We conducted a Discrete Choice Experiment study in Normandy, northwestern France, targeting  
41 over 1310 farmers. We received 110 usable responses. The response rate, as well as the sample  
42 size, are relatively low<sup>12</sup>. Five attributes describe different grassland restoration contracts: the  
43 land enrolment rate, the annual payment, the availability of free technical support and advisory  
44 services, the possibility of collective enrolment, and the option of receiving a financial premium  
45 in return for complying with the scope and spatial distribution conditions of the enrolled land.  
46 We used collective enrolment to refer to the collaborative effort between farmers toward  
47 grassland restoration. We have provided insights into two main categories of factors that can

---

<sup>12</sup> Normandy has 26500 farms.

1 influence participation as well as non-participation (choosing the status quo option), (i) the  
2 contract characteristics and (ii) farmers' and farms' characteristics.

3  
4 Overall, farmers prefer flexible contracts and wish to keep the decision power over the  
5 percentage of land to be enrolled in the contract. Because we have an overrepresentation of  
6 small farms in our sample, it is possible that we under-evaluate the effect of higher percentages  
7 of land enrolment on farmers' decisions. This observation is a common conclusion in the  
8 literature, as stringent management prescriptions and less flexibility in implementing  
9 conservation practices reduce farmers' willingness to participate (Ruto & Garrod, 2009).  
10 Farmers prefer flexible contracts that allow them to react to ever-changing market and weather  
11 conditions (Hasler et al., 2022; Viaggi et al., 2021).

12  
13 Technical support increased farmers' likelihood of enrolling in grassland restoration contracts by  
14 5%. It is useful to mention that there is a widespread perception among French livestock farmers  
15 of grassland being an outdated and unsuitable technical model. The fodder deficit associated  
16 with the drought and heat wave episodes over recent years further reinforces this assessment  
17 (Michaud et al., 2020). Thus, farmers need to receive technical advice on best practices for  
18 managing grassland, their fields, and fodder systems with diverse environmental conditions and  
19 agronomic and ecological potential (Michaud et al., 2020). Fleury et al. (2015) underscore the  
20 positive relationship between farmers' positive value of biodiversity and their requirement for  
21 training, education, and advice within a scheme aimed at grassland restoration. Moreover,  
22 Schroeder et al. (2013) found that although English dairy farmers were uncertain if they would  
23 achieve the ecological target from grassland restoration, they considered joining the proposed  
24 AES to benefit species richness in grasslands if professional advice was available. Finally, while  
25 Matzdorf & Lorenz (2010) suggest that the availability of professional advice would increase the  
26 willingness of risk-averse farmers to participate in AES, Del Rossi et al. (2021) argue that  
27 farmers can expect costs to be lowered as a result of these services.

28  
29 Our findings highlight that higher payment levels and the *Premium* offered for the increased  
30 extent of the interconnectedness of contracted land improve the likelihood of farmers signing a  
31 grassland restoration contract. In addition, farmers' mean WTA to change their farming practices  
32 is even smaller than the range of payments offered during the survey. There are, however,  
33 significant payment expectations at the top of the suggested levels. Farmers require  
34 compensation to cover additional costs and even to be as lucrative as their current land use<sup>13</sup>.  
35 This is consistent with Lakner et al. (2020) study on farmers' preferences for targeted grassland  
36 conservation in eastern Germany, concluding that those additional costs constitute a significant  
37 barrier to farmers' adoption, particularly for farms focusing their farm management on  
38 productivity and profitability optimization.

39  
40 Farmers in our sample seemed reluctant to join a collective contract involving collaboration, and  
41 the range of WTA is relatively significant. This is in line with previous findings. Villanueva et  
42 al. (2015) explain farmers' reluctance through their apprehension of being controlled by the  
43 other group members. We may expect further dedicated studies to help understand how  
44 attaching more significant sign-up payments to collective participation could impact farmers'  
45 decision to enroll adjacent land parcels within collective grassland restoration contracts and  
46 maximize ecological benefits.

---

<sup>13</sup> Compared to income obtained from other crops ranging between 750 and 2200€/ha depending on crop type in Normandy, the compensation offered by the grassland restoration contract only amount to €330/ha.

1 Our findings offer compelling evidence that knowledgeable farmers about grassland ecosystem  
2 services understand that successful restoration schemes need to involve large-scale actions that  
3 require them to work closely with their neighbors in a cross-farm boundary. They, therefore,  
4 tend to accept to join a contract collectively. This evidence is of interest because studies have  
5 demonstrated that farmers' views of the potential success of AES are a significant determinant of  
6 their participation (Siebert et al. 2006). Sutherland et al. (2012) suggest that when prescribed in  
7 a contract, collective participation can help share experiences among neighbors and,  
8 consequently, lowers both the uncertainty of AES implementation on farm management and the  
9 pressure to comply with social norms. These observations are also consistent with studies on  
10 environmental psychology that identify how social pressure can influence farmers' perception of  
11 their ability to undertake a particular measure and assess their resources. Michel-Guillou and  
12 Moser (2006) state that social pressure can even trigger environmental awareness. It also leads  
13 to win-win outcomes in terms of both productivity and reducing environmental impact (Daxini  
14 et al., 2018; Rezaei et al., 2019)

15  
16 Two other findings worth mentioning. First, while farms' characteristics (limited dominant  
17 crops, high livestock unit per hectare, and high dairy stoking rate) explain limited farmers'  
18 enrolment in the contract, farmers' characteristics (age, availability of external income, and  
19 environmental attitudes) clarify their choice of moving away from the status quo. Second,  
20 farmers' environmental knowledge about ecosystem services provided by grassland plays a role  
21 in their decision (about 61% of the sample). These farmers tend to combine environmental  
22 management with their farming goals, including conservation stewardship, production, and  
23 profitability, which is consistent with the literature (Wheeler et al., 2018).

24  
25 There are some policy implications for our results. According to experts, one of the critical  
26 priorities in determining the extent to which the new Common Agricultural Policy green  
27 architecture tackles the biodiversity crisis will heavily depend on massive effort put into  
28 grassland restoration by farmers (Pe'er Guy et al. 2021). In addition to achieving more  
29 comprehensive ecological outcomes at a landscape scale, collective, collaborative participation  
30 is a valuable tool for reducing the number of contracts signed by groups of farmers involved in  
31 grassland ecological restoration. For collective contracts to be effective, national, and regional  
32 grassland restoration agendas must be harmonized with site-level goals. For example, the local  
33 authority could define an inclusive and comprehensive distribution of grassland areas that  
34 should be restored, given their potential ecological advantages. In this case, the policy would  
35 have to specify a share between neighboring farmers of the ecological restoration requirement  
36 within a contract that involves collective participation and promotes a "*neighborhood effect*"  
37 supporting farmers' collaborative efforts (Defrancesco et al., 2018). Our results show, however,  
38 that farmers prefer flexible contracts. This measure might impact the participation rate.  
39 Therefore, setting a cost-effective monetary incentive is critical to promoting collective  
40 participation in the scheme. Including collective participation in the grassland restoration  
41 scheme could also reduce implementation costs for the regulator (Banerjee et al., 2014).  
42 Although previous CAP. regulations included a 30% bonus to promote such participation, the  
43 uptake of these schemes is low, and there is little known about farmers' (non)resistance to such  
44 schemes (Riley et al., 2018). Further research is needed to understand and manage farmers'  
45 expectations and perceptions about collaborative contracts and fill the knowledge gap about  
46 costs and practical gains from farmers' collective participation in grassland ecological restoration  
47 schemes.

48  
49 Our results show that increasing the enrolled acreage per farmer by setting a conditional  
50 monetary premium could positively impact farmers' participation. Even if it will translate into an  
51 increased cost per signed contract for the developer (Vaissière et al., 2018), designing schemes

1 that include conditional monetary premium would maximize the odds of reaching acres  
2 thresholds for successful ecological restoration of grasslands.

3  
4 The heterogeneity of preferences observed among farmers in our study favors differentiated  
5 payments when possible. Besides, it uncovers an appealing scope for further exploration of  
6 contracts targeting small, extensive dairy farms with low stocking densities. These small-scale  
7 farming systems are essential as they create and maintain species-rich semi-natural grasslands  
8 (Babai et al., 2015). Even if the trend is widespread in Europe, the number of small dairy  
9 grazing farms in France has decreased by a third since 2010 (Ben-Othmen et al., 2020).  
10 Policymakers must deal with the compounded economic pressure on these farms, including milk  
11 price instability and uncertainty that continuously challenged their business operations (Clay et  
12 al., 2020) and caused many farms to expand their herds and change management practices to  
13 sustain their visibility.

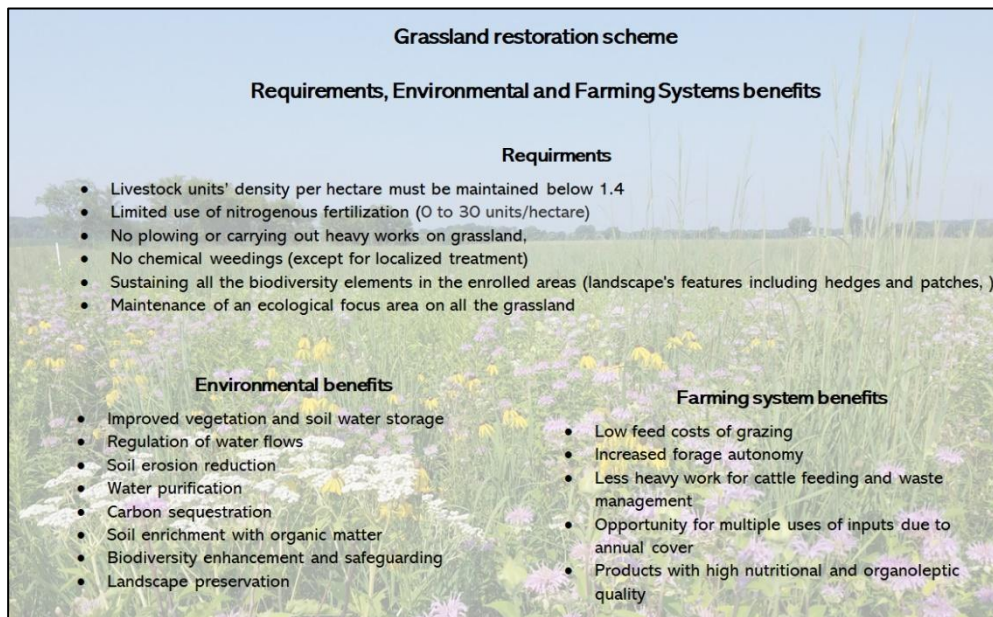
14  
15 The post-2023 CAP offers ground to expand the scope and possibilities for grassland restoration  
16 beyond their sole prescription as good agricultural and environmental conditions. Our results  
17 contribute to the debate on the opportunities this reform offers to transition towards sustainable  
18 agriculture. We also identify two potential interventions to reinforce grassland restoration in the  
19 new CAP green architecture. First, because outside revenue may encourage participation,  
20 increasing area-based payments funded under Pillar 1 (article 31- CAP. 2021-2027) that reserve  
21 part of its funding for environmental performance payment might be required. In this context,  
22 eco-scheme can be valuable in supporting the maintenance of farmers' income, mainly during  
23 phases of transition that involve restructuring farming systems and investments in new practices.  
24 Interestingly, eco-schemes can potentially target specific environmental issues across entire  
25 regions (Lampkin et al., 2020). However, they differ from agri-environmental and climatic  
26 schemes as they can offer farmers payments beyond the income loss and the direct costs of  
27 implementing environmental measures. Therefore, payment under an eco-scheme, regardless of  
28 production levels, could help secure income for dairy farmers who rely on extensive grazing  
29 systems and improve their profitability. Second, our findings suggest that promoting large-scale  
30 conservation via collective action schemes under Pillar 2 can strengthen other measures that  
31 have shown promise in supporting grassland preservation and improving the overall biodiversity  
32 of farmland. Such measures encompass result-based schemes (Chaplin et al., 2019), support for  
33 mixed-species grassland (Dumont et al., 2022), and investment for silvo-pastoral ecosystems  
34 establishment (Helena Guimarães et al., 2023).

35  
36 There are many limitations to our study. Although our sample can represent several key figures  
37 of the Normandy farmers' population, it is relatively small; therefore, our results must be  
38 considered with vigilance and are, by no means, representative of the entire population of  
39 farmers in France. Additional research is needed to unveil preferences for collective  
40 participation in the contract and how nudges can be used to start group dynamics toward  
41 improving grassland ecological benefits at the landscape level. Another shortcoming of our  
42 study is that it does not specify what collective participation would mean in terms of  
43 collaborative efforts to achieve effective ecological outcomes. In fact, grassland restoration  
44 programs need to be designed to achieve semi-natural permanent cover from ryegrass and  
45 include measures to improve their biological diversity. Further research is needed to examine  
46 what is precisely required by farmers within the collective contract to deliver these ecological  
47 benefits while using fewer farm resources than in an individualized contract. In addition, we did  
48 not include details about how this collective participation could be implemented financially and  
49 the benefits for farmers from enrolling in such a contract. These aspects need to be considered in  
50 further studies.

51

1 This paper addresses the need for effective instruments to complement France's current  
 2 Grassland Conservation Program. It is the first attempt to measure and help understand the  
 3 relative importance farmers attach to the contract's attributes targeting grassland ecological  
 4 restoration and how farms' and farmers' characteristics determine the heterogeneity of  
 5 preferences. Additional studies of this type would help substantiate or upgrade the obtained  
 6 results using data from other samples of farmers.

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22 **Append 1. - Grassland restoration scheme: on-farm management requirements presented**  
 23 **surveyed farmers.**  
24



25  
26  
27  
28  
29 **Appendix 2 - Environmental attitudes as a Farmer – adapted from (Vogel, 1996)**  
30  
31

| Indicate your agreement or otherwise with the statements below   |                   |          |       |                            |       |                |
|--|-------------------|----------|-------|----------------------------|-------|----------------|
|  | Strongly disagree | Disagree | Agree | Neither Disagree Nor Agree | Agree | Strongly agree |
| Agricultural activities today lead to the destruction of natural biotopes and a reduction in wildlife and wild plants. |                   |          |       |                            |       |                |
| Grassland conversion into cropland reduces the continuing biological productivity of the land and the product quality. |                   |          |       |                            |       |                |
| The use of chemical substances in agriculture works against nature.  |                   |          |       |                            |       |                |
| The media exaggerate environmental problems resulting from agricultural activities.                                    |                   |          |       |                            |       |                |
| The groundwater burden resulting from washing out of fertilizers is worse than people could imagine.                   |                   |          |       |                            |       |                |
| Farmers are the best protectors of the natural environment, even if mistakes are made occasionally.                    |                   |          |       |                            |       |                |
| Commercial fertilizers and pesticides have no harmful effects; they promote high-quality production.                   |                   |          |       |                            |       |                |
| Using chemicals in agriculture makes sense as long as it brings greater returns than                                   |                   |          |       |                            |       |                |
| Maintaining a proper balance in nature requires a more complex form of operational organization.                       |                   |          |       |                            |       |                |

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