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Combining management plans and payment schemes for targeted grassland conservation within the Habitats Directive in Saxony, Eastern Germany

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ABSTRACT

As central policies for biodiversity conservation in agricultural landscapes in the European Union (EU), the Habitats Directive and Agri-environmental programmes (AEP) have largely failed to halt biodiversity loss. In response, the German federal state of Saxony combined the instrument of management plans with AEPs to support the implementation of the Habitat Directive. In this study, we investigate the determinants of a farmers' decisions to adjust their farming practices. Our data set consists of a quantitative survey with 131 farmers conducted between 2004 and 2011, complemented by implementation data from 333 grassland-plots. Determinants of farmers' decisions to conserve grassland were estimated using a multinomial logit model. Our results show that a combination of management plans and AEPs can increase farmers' disposition to adopt nature conservation measures. As central determinants, structural and location factors as well as the complementary provisiion of specifically designed AEPs increase farmers' willingness to adopt conservation practices for grassland management. It can be concluded that additional costs are a major barrier to farmers' adoption, particularly to those farms directing their farm management towards the optimisation of productivity and profitability . The findings highlight the complementary potential of integrated policy packages to incentivise specific measures of nature conservation within the framework of the Habitats Directive.

1. Introduction

Agricultural intensification is a major cause for biodiversity loss, both globally (Beckmann et al., 2019; IPBES, 2019) and in Europe (IPBES, 2018). Studies on German conservation areas indicate a decline of biomass of flying insects by 78% over the last three decades (Hallmann et al., 2017), about 34% of bird species in Germany were declining between 1998 and 2009 (Sudfeldt et al., 2013) and arthropod biomass on grassland declined by 68% between 2008 and 2017 (Seibold et al., 2019). In addition, the abundance of typical grassland birds like e.g. the Meadow Pipit (*Anthus pratensis*) has declined by 60%-points since 1990 (DDA, 2019). Farming practices can be decisive to halt species decline in agro-ecosystems. The conservation and support of grassland biodiversity strongly depends on farming practices and farmers' attitudes towards nature conservation (Batáry et al., 2015). Biodiversity friendly farming requires farmers, as the central 'stewards' of agricultural landscapes, to adopt extensive and ecologically sound farming practices. In the past, several policy instruments have been introduced to regulate ecosystem management, incentivise biodiversity supporting practices in agricultural landscapes, and compensate farmers and other landowners for resulting costs.

With the MacSharry reform of the Common Agricultural Policy (CAP) in 1992, the EU introduced voluntary payments for Agri-Environmental Programmes (AEPs) to incentivise the integration of conservation activities into farming practises, accounting for 772 Mio. EUR annually in Germany (BMEL, 2019: incl. national and EU funding). AEP funding (including organic farming support) accounts for 10.4% of the CAP budget of in total 7.26 bn. EUR in Germany, whereas most of the CAP funds (67%) are spent as direct payments (BMEL, 2019; DBV, 2019). There is a large body of literature on the effectiveness of AEPs (e.g. Batáry et al., 2015; Kleijn et al., 2006; Uthes and Matzdorf, 2013) and on farmers' AEP uptake (Brown et al., 2019; Lastra-Bravo et al.,

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2015), generally highlighting the potential of effective AEP measures. In practice, this potential is undermined by both offering ineffective measures and weak implementation frameworks that fail to adjust programs to regional and ecological contexts (Batáry et al., 2015). While there is an overlap of AEP implementation with the EU's Natura 2000 network of conservation areas, only little light has been shed on the relationship between AEPs and Natura 2000 policies in the context of agriculture.

The EU Birds Directive (Directive 79/409/EEC of 1979) and the EU Habitats Directive (Directive 92/43/EEC of 1992) are key instruments of the EU's Biodiversity Strategy Natura 2020 aiming at the observation and conservation of biodiversity in '*Special Areas of Conservation* (SACs)' (EU Commission, 2011c, 2015). Both the Birds and the Habitats Directive are central instruments for the governance of Natura 2000 areas currently covering 18% of the EU's land surface area. In Germany, about 5.52 Mio. ha land are designated as Natura 2000 areas in 2015, taking 15.5% of the total terrestrial area (including agricultural and non-agricultural land), which may be large in absolute terms, however below the average EU-28 share (EU Commission, 2019).

The literature shows, that the Habitats Directive is supporting the maintenance and conservation of biodiversity (Pellissier et al., 2019). For Germany, the Natura 2000-assessment indicates that the numbers of habitats and species with '*unfavourable -bad*' conservation status increased over the period from 2007 to 2018 from 25% to 33%, whereas the habitats with favourable status largely remained constant (BfN, 2019; BMUB, 2013). In response, especially since 2007, complementary policies such as AEPs have been applied to improve biodiversity conservation in Natura 2000 sites. In 2014-17, on average 17.8% of the AEP payments in Germany were paid on land being designated within the Natura 2000-framework (BMEL, 2018), which is 0.94% p.a. of the total CAP-payments for Germany.

To date, little has been reported on the behaviour and preferences of farmers when economic (AEPs) and regulatory instruments like the Habitats Directive are combined. We help filling this gap by analysing a unique farm-level data set, containing information of farm structures, agri-environmental support and implementation details of the Habitats Directive. In general, *'Special Areas of Conservation (SACs)'* including farmland are designated and implemented top-down (Appendix B), providing only little participation of local stakeholders (Geitzenauer et al., 2015; SMUL, 2013).

We focus on the case of Saxony, where the implementation of the Habitats Directive provides some freedom of decision for farmers, in contrast to other regions. Saxony is an exception, as the implementation of the Habitats Directive is to a large extent voluntary for farmers. In Saxony, about 292.7 thousand ha (15.9%) of the area are registered as SACs (SMUL, 2018). Generally, in 2013 about 33% of grassland and 42% of arable land in Saxony is used within the support of AEPs (SMUL, 2013). In our dataset, 57% of the farmers using farmland in SACs in Saxony participate in AEPs, indicating a strong interdependence of both instruments.

The federal state government of Saxony has developed a new approach of specific management plans (MaPs) to integrate the objectives of the Habitats Directive into AEPs (SMUL, 2007). MaPs are related to SACs and consist of larger areas (16 to 4.300 ha), which in Saxony are in most cases located along rivers, with a length of between 5 and 124 km. MaPs identify the *'habitat types'* on grassland as defined in annex 1 of the Habitats Directive within the SACs. The MaPs determine the respective conservation status for SACs, develop specific conservation measures and communicate with farmers over implementation within existing AEPs in the state of Saxony.

After the introduction of AEPs in 1992, farmers participated in AEPs and thereby supported the maintenance of biodiversity (1, see Fig. 1). From 2004 onwards, MaP and AEPs have become complementary instruments to implement the objectives of the Habitats Directive in Saxony. Appropriate measures to maintain the conservation status of a habitat type have been developed by private planning offices (2, see Table C1). Planning offices contacted implementing farmers and asked them, if they would be willing to further adjust their grassland use with respect to the measures foreseen in the MaPs, largely on a voluntary basis (3).

In this paper, we investigate the participation in MaP developments and farmers' motivations to implement grassland measures in Saxony. Our analytical approach is based on the hypothesis that voluntary AEP can increase motivation of farmers to implement measures suggested by MaPs. Our study combines a unique dataset of SCI, where different AEPs and additional requirements of the Habitats Directive are applied. We base our analysis on a quantitative survey, which was conducted within the information process (see Fig. 2) of 17 different MaPs across Saxony between 2004 and 2012, interviewing farmers who are actually farming on SCIs. In this survey, we interviewed 131 farms managing 333 plots inside SACs on their conservation practices, participation in AEPs and general farm characteristics (related to production and location factors). We recorded farmers' actual conservation decisions as well as farm and plot characteristics, which will we assume will influence the conservation decision. Based on a theoretical model, we investigate the willingness of farmers to adjust the use of grassland. Our results provide key insights on factors driving the successful implementation of the Habitats Directive on grassland farms in Eastern Germany and show the strengths and limitations of the 'Saxonian implementation model' of the Habitats Directive.

2. Background

2.1. Background of the management plans (MaPs)

In Germany, the federal states are responsible for the implementation of the Habitats Directive. This involves the identification of measures aiming to maintain species and habitats according the Habitats Directive. We base the description of the process on the case of Saxony; however, the implementation of the Habitats Directive is similar in other federal states. In contrast to some other federal states, Saxony has included both the documentation process of species and habitats and the identification of measures to maintain favourable conditions into one step, resulting in the SAC management plans (MaP).

Involvement of farmers into the MaP planning process is legally required, because according to the Habitats Directive (Art. 6, § 4), '*other plans*'[1] which might interact with the objectives of Habitats Directive, have to be assessed for potential impacts on the MaP. Therefore, agricultural practices which are relevant to the objectives of the SACs are documented in the MaP (see Table 1 for examples). In Saxony, the MaPs are developed by private planning offices and approved and financed at the federal state level. The typical MaP follows a structured process described in Fig. 2.

In the first stage, the private engineering offices document the species and habitats of interest based on the annexes of the Habitats Directive. At the second stage, potential conservation measures are developed (as e.g. late mowing regimes or restricted fertilization, see also Table C1 in the appendix C). The third stage involves consultation with affected farm enterprises, which consists of (a) information on the objectives of the Habitats Directive and the management plan (MaP), (b) an interview on the land use system of the specific grassland, (c) an indication of the farmer's willingness to implement proposed conservation measures and (d) a report on other farm characteristics that could potentially conflict with the conservation objective of a habitat type. A list of farmers is provided by the authorities, and some of the interviewed farmers were identified during the documentation process. We therefore interviewed only farmers who were farming on grassland

[1] '*Other plans*' can be infrastructure measures such as transportation, infrastructure or water management plans, but also typical agricultural practices (EU Commission, 2000), which can be considered as '*farm-plans*'.

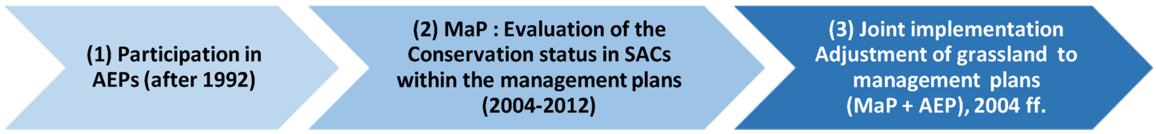

Fig. 1. Timeline of the sequential introduction of Agri-environmental programmes (AEPs),[3] Management plans (MaPs) for the management of Special Areas of Conservation (SACs) and the joint implementation in Saxony Source: own presentation.

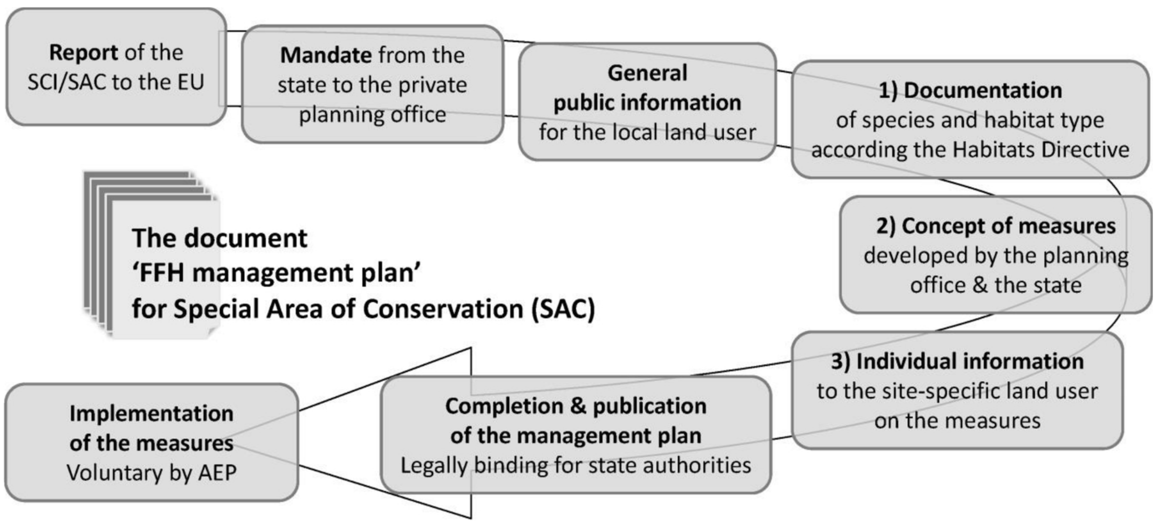

Fig. 2. Process of the management plan (MaP) development in Saxony Source: own presentations, based on Franke (2008); Note: SCI = Sites of Community Interest; SAC = Special Area of Conservation; AEP = Agri-environmental Programme.

Table 1
Agri-environmental programmes for implementing the Habitats Directive in Saxony.

Program name	Description*	Payment
KULAP (2000-2006)	Part of the program '*Environmental-friendly Agriculture*' ('Umweltgerechte Landwirtschaft (UL)'). A basic extensification programme for grassland, no chemical fertiliser and plant-protection, in some cases cutting only after the 15 June is allowed.	102-204 €/ha
NAK (2000-2006)	A program for '*Nature conservation and sustaining cultural landscapes*' ('Naturschutz und Erhalt der Kulturlandschaft (NAK)'): A site-specific programme similar to KULAP but with mowing regimes after 15 June and 15 July.	360-450 €/ha
Organic Farming (2000-2013)	A Program to promote an organic farming scheme according to the Regulation EU-VO 2092/91.	244 €/ha (2000-2006) 237 €/ha (2007-2013)
AUW (2006-2013)	A basic programme for grassland extensification, i.e. no chemical fertiliser and plant-protection. It is possible to mow the grassland or keep grazing animals on the plot.	102 €/ha
AUW 35 (2006-2013)	An advanced programme for butterfly *Glaucopsyche nausithous* (Dusky Large Blue, see measure 3 in Table C1) Prohibits the application of chemical fertiliser and plant-protection, and limits mowing to before June 15th, or after Sept 15th, while allowing sheep and goat grazing. Grazing density is restricted.	350-373 €/ha

Source: own description; Simplified, based on (SMUL, 2007, 2015), * For most of the programmes on grazing systems within KULAP, NAK, and AUW, the livestock density is restricted to 1.4 livestock units per hectare.

with a minimum species diversity.

Adding to the regular habitat types, the MaP must contain 'development plots', which are plots that currently do not comply with the requirements of the Habitats Directive but have the potential to do so given appropriate conservation measures. These plots are a strategic reserve to be activated, if implementation is not sufficiently successful in the identified SACs, and the share of implemented measures insufficient throughout Saxony to comply to the EU's targets.

In the fourth stage, results from steps 1, 2, and 3 are summarized in the document 'Management Plan (MaP)', which is the legally binding document for the state institutions to finalize the implementation, however not for land users. This legal detail should be noted as specific to Saxony in contrast to other federal states, where the MaP is also legally binding for land users. The suggested conservation measures are designed for the respective sites, taking into account a uniform recommendation with respect to the level of fertilisation on grassland within the state of Saxony (Franke and Riehl, 2005)[2] (see examples in Table C1).

Within the interviews, critical remarks are documented, and the farmers can choose between non-participation, compromise regime and full commitment. In regional working groups, also other stakeholders (e.g. other enterprises or environmental NGOs) can give a statement on the measures. Therefore, the MaPs provide some participatory elements.

The planning method also allows for '*site-specific compromises*', where the farmer and the engineering office agree on a technically

[2] Parts of the compromise regimes are implemented with dark-green and parts with light-green measures, see Table C1.

[3] Following CAP-reform 2013 these programmes were changed to agri-environmental *and climate* measures (AECP). However here, we refer to the periods 2000-2006 and 2007-2013 and use the term AEP.

more feasible measure, without fully compromising conservation targets, which we further on call a '*compromise regime*'. For example, this may apply to grazing regimes with suckler-cows: This grassland-regime is not optimally mowed to reach the ideal habitat quality for the habitat type '*Lowland hay meadow*' (No. 6510, similar to *Arrhenaterion*). But instead of two mowing regimes, cattle grazing (and potentially one mowing regime) can be used instead, without substantially sacrificing biodiversity targets.

2.2. Relationship between MaP implementation and AEP participation

One important objective of the MaP is to assess and document the willingness of farmers to adjust their grassland use and to fully or partly implement the measures of the MaP, which was part of the respective MaP-consultation process with farmers. In general, due to similarities between the proposed measures in the management plan and the AEPs, we can expect a similar pattern for measure uptake. However, in specific cases as outlined in Table C1, both MaP requirements and AEP requirements, on which financial support mechanisms are based, diverge (see Table 1 for an overview of AEPs relevant for the MaPs).

Thus, we can expect differences in the stated '*willingness to adjust*' and participation behaviour. Based on the interviews with farmers, we can in general distinguish between two situations:

1 Since implementation is voluntary, it is important to evaluate the willingness to use the grassland in accordance with the management plan. This implementation is often, but not necessarily related to in AEP participation. In some cases, an adjustment of grassland-use is possible without any financial support (which was sometimes even economically rational considering administration costs for a farm to participate in an AEP).
2 For farmers already participating in AEPs, the focus lies on the details of the adjustment, which was in some cases not trivial despite financial support for the program. For some farmers, a change to a more complex ('dark-green') AEP with higher payments was attractive, in other cases not.

Some of the main arguments against an adjusted grassland use are conflicting requirements between AEPs and measures of the MaPs. For instance, mowing regimes according to an AEP (mowing after June 15) are often stricter than required by the MaP, where the mowing date is based on plant-phenotype and not on strict dates. The binding criterion is the AEP with its strict date, which does not incorporate unforeseen events such as weather.

Fig. 3 gives an overview on the potential impacts of MaPs in Saxony:

2.3. A short literature review on AEP adoption

Various studies show how policy implementation strategies determine conservation outcomes while balancing interests (Geitzenauer et al., 2015; Hochkirch et al., 2012; Young et al., 2013). The mix of social and economic factors that determine farmers' adoption makes conservation practices a controversial issue in rural German agricultural landscapes (Prager and Posthumus, 2010). Depending on contextual and methodological differences, the literature agrees on some aspects, while pointing to some more case specific causalities (Brown et al., 2019).

A general resistance to changing farming practices has been connected to certain mental models and self-perceptions that evolve as a result of technological path-dependencies (Vuillot et al., 2016). While financial considerations are an important driver, there are often practical considerations. Fit of measures within farm structures plays an important role in the uptake of AEPs (Herzele et al., 2013). Nevertheless, literature points to specific factors that correlate (positively or negatively) with farmers' uptake of conservation measures.

Farm location is another variable that has been related to geographical variation of conservation activities (Zinngrebe et al., 2017). For example, negative effects on land value is a factor that deters the adoption of environmental measures (Barreiro-Hurlé et al., 2010; Bartolini et al., 2012). Also, farmers in mountainous areas were more likely to favour the implementation of conservation measures (Borsotto et al., 2008). In a survey in Slovenia, Šorgo et al. (2016) found that the perspective of a higher quality of life prioritised in Natura 2000 areas incentivises the adoption of more ecologically sound practices.

Ecological considerations also affect farmers' AEP decisions. For instance, farmers with land located close to water bodies or in ecologically valuable areas have been found to be more likely to participate (Grammatikopoulou et al., 2012). Schüler et al. (2018) show that in the case of Greening, ecological considerations play a minor role in decision-making processes, especially given that some farmers even cast doubts on the positive ecological impacts of some of the greening measures (Schüler et al., 2018).

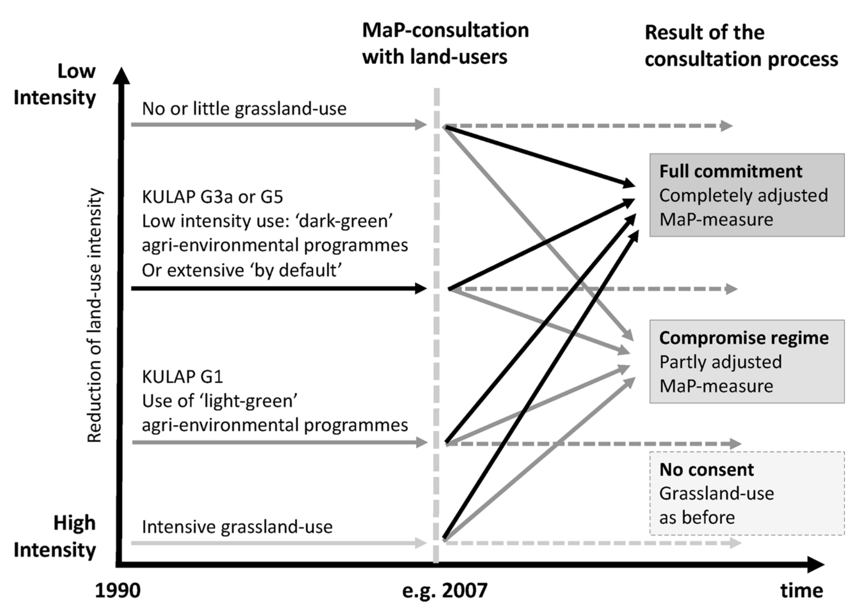

Fig. 3. Potential impacts of management plans in Saxony. The dotted lines signal no substantial change in grassland-use due to the consultation. Solid lines show the options of improvements to 'compromise regime' or 'full commitment'. (Source: own presentation).

Economic considerations and profitability are a central in farmers' decisions (Zanten et al., 2014). Several studies show that the profitability of a farm is negatively correlated with willingness to participate in conservation measures (Lastra-Bravo et al., 2015; Ruto and Garrod, 2009). Farms which intensively use land (e.g. with high livestock densities), and therefore with high value added per hectare, are less likely to engage in conservation measures (Breustedt et al., 2013; Espinosa-Goded et al., 2013; Grammatikopoulou et al., 2012; Micha et al., 2015).

Financial support through AEPs is a central factor in the adoption of conservation measures. Many studies find a direct link between the subsidy and the adoption of environmental measures in Germany (Bock et al., 2013), Italy (Borsotto et al., 2008), Ireland (Di Falco and Rensburg, 2008) or EU-wide (Ruto and Garrod, 2009). However, for most farmers in a study on grassland, low financial incentives were not the main reason for not participating in an AEP (Hammes et al., 2016). There are however limits to voluntary schemes, such as AEPs, as they are competing with other more attractive economic incentives (Santana et al., 2014). Hence, a real economic incentive for conservation only exists if payments supersede all costs involved, including learning costs, costs related to changing perception and satisfaction, uncertainties or risks of penalties (Prager and Posthumus, 2010). Extra bonus payments (e.g. for longer contracts), and higher shares of total farm revenue generated by AEPs were found to lead to higher participation in AEP schemes in Germany (Drechsler, 2017; Mante and Gerowitt, 2009). Breustedt et al. (2013) find a subsidy level of between 100–200 EUR/ha is necessary to convince farmers to participate in conservation activities. In the same vein, farms with lower land use intensity favour participation in AES (Breustedt et al., 2013; Zimmermann and Britz, 2016).

Farm size and other farm characteristics have been shown to correlate with AEP participation (Ruto and Garrod, 2009; Zimmermann and Britz, 2016). Farms with larger land endowment rather tend to participate in AEP (Damianos and Giannakopoulos, 2002; Vanslembrouck et al., 2002; Zimmermann and Britz, 2016). Mann (2005) has found smaller farms to be more likely to participate in agri-environmental schemes, this however can be related to the specific design of AEP in Switzerland. A Survey in Poland showed particularly large farms to perceive Greening and administrative hurdles as being unfair. Furthermore, more than half of the respondents to this survey Poland see the value of environmental measures for enhancing productivity of their land (Świtek and Sawinska, 2017). Other farm characteristics show diverging influences on conservation engagement: While part-time farmers are found to have a stronger disposition of adopting conservation measures, as two studies in Denmark and on the European level show (van Vliet et al., 2015; Vesterager and Lindegaard, 2012), other studies in Germany attest that full-time farmers are more likely to adopt measures (Mante and Gerowitt, 2009; Matzdorf and Lorenz, 2010). Stoll (1999) finds that farmers who perceive their land primarily as a production resource are less likely to participate in AEPs and are more likely to hold negative perceptions of conservation policies. By contrast, work on the perceptions of Norwegian farmers shows two distinct types of farmers: those who reject the idea of payments for public goods in favour of productivity and those farmers who give importance to cultural landscapes (Kvakkestad et al., 2015).

The design of the implementation process was furthermore shown to influence conservation performance. The case of Austria shows that higher conservation efforts were observed if there was no full prior consent from all landowners (Geitzenauer et al., 2015). Analysing the variation across different federal states in Austria, the highest ecological outcome was reached in Burgenland, Styria, Upper Austria, due to a compromise-oriented implementation model (Geitzenauer et al., 2015). While biodiversity and ecosystem variety need structural diversity, Santana et al. (2014) suggest that most effective performance is achieved when combining adequate regulations with funding schemes.

For our analysis, we will mainly focus on the impact of political incentives, structural factors and ecological assessment of habitat types, however based on our unique dataset, which on the other hand does not contain information on motivational factors or perceptions.

3. Data and methods

3.1. Optimisation of grassland use: theoretical model

The adoption of grassland optimisation measures by farmers will depend on the individual farmer's profit, but also on transaction costs and attitudes towards environmental protection. Based on the model by Vanslembrouck et al. (2002), a farmer's indirect utility function is therefore a function of income (i.e. profit π), grassland optimisation (Opt), and other characteristics Z.

$$U = U(\pi(X(Opt),\, T(Opt)),\ Opt,\ Z) \tag{1}$$

where we define T as switching costs and X as Inputs. The farmer's profit is defined as

$$\pi = pf(X(Opt)) - wX(Opt) - T(Opt) \tag{2}$$

as a function depending on outputs and the sum of inputs X, multiplied by input prices w and switching costs T.

In this unconstrained optimisation problem, the farmer is assumed to choose his level of conservation along a continuum in order to maximize his or her utility. The first order condition with respect to grassland optimisation is

$$\frac{\partial U}{\partial \pi}\left[p\frac{\partial f(X(Opt))}{\partial X}\frac{dX}{dOpt} - w\frac{\partial X}{\partial Opt} - \frac{dT}{dOpt}\right] + \frac{\partial U}{\partial Opt} = 0 \tag{3}$$

Or

$$\frac{\frac{\frac{\partial U}{\partial Opt}}{\frac{\partial U}{\partial \pi}} - \frac{dT}{dOpt}}{\frac{dX}{dOpt}} = -p\frac{\partial f(X(Opt))}{\partial X} + w \tag{4}$$

The standard case without conservation measures would be $p\frac{\partial f(X(Opt))}{\partial X} = w$, where the value of the private marginal product equals the private marginal cost. This means that a farmer will increase input use until the value of the marginal product is equal to its marginal cost. It is reasonable to assume that even a farmer who is very fond of the environment will not go beyond this point, as doing so would lead to a sub-optimal utility level or in an extreme scenario drive him/her out of business. Therefore, $p\frac{\partial f(X(Opt))}{\partial X} >= w$.

A discrepancy between the value of the marginal product and the marginal cost could then be explained by a farmer's attitude towards the environment ($\frac{\partial U}{\partial Opt}$), as well as the business characteristics of grassland optimisation. In this case, the term on the right-hand side of Eq. (4) turns negative.

First, we can analyse the effect of $\frac{dX}{dOpt}$. This can be interpreted as an indicator of changes in farming methods (or, more accurately, input choice) with respect to the optimisation level. The larger the change in input use due to the conservation measure in absolute terms, the less likely a farmer will adopt grassland optimisation, as the left-hand side would approach zero. Farmers may be reluctant to optimise if it involves large changes from their current status quo. Note that $\frac{dX}{dOpt}$ is in all cases negative: if we reach a higher optimisation level (Opt), input-levels (X) will be reduced and vice versa.

The numerator of the left-hand side, $\frac{\frac{\partial U}{\partial Opt}}{\frac{\partial U}{\partial \pi}} - \frac{dT}{dOpt}$, includes a farmer's attitudes towards grassland optimisation (the utility that a farmer gains from optimisation beyond the pure income effect). If a farmer has a positive utility gain from conservation beyond profit, then $\frac{\partial U}{\partial Opt} > 0$ and therefore $\frac{\frac{\partial U}{\partial Opt}}{\frac{\partial U}{\partial \pi}} = MRS_{Opt,\pi} > 0$.

In addition, standard economic theory suggests that $\frac{\partial U}{\partial \pi} > 0$ is concave, which means that it will be smaller at larger incomes compared to lower incomes. As income increases, ceteris paribus, $\frac{\frac{\partial U}{\partial Opt}}{\frac{\partial U}{\partial \pi}}$ will also increase. Intuitively, farmers with an already higher income would place less value on additional income compared to additional conservation, making a positive conservation decision more likely as long as marginal switching costs and the marginal utility from conservation stay the same. Some empirical studies find that the utility of conservation and thereby the willingness to adopt is affected from the actual household income (Soule et al., 2000) or that farm profits might play a different role, if other income sources become more important (Lambert et al., 2007). However, in our model we implicitly assume, that the marginal utility of conservation (which may be determined by attitudes or household goals) is, at the margin, independent of a marginal income change. This result may not hold for large income changes.

If the change in switching costs T with respect to optimisation is equal to or larger than $MRS_{Opt,\pi}$, then the result of the left-hand side will be zero or positive, hence, no grassland optimisation will be implemented.

Given $MRS_{Opt,\pi} > 0$, $\frac{dT}{dOpt} > 0$ and $MRS_{Opt,\pi} > \frac{dT}{dOpt}$, the left hand side will only be negative if $\frac{dX}{dOpt} < 0$ and if $\frac{dX}{dOpt} > -\infty$. This is intuitive; farmers will only participate if they have a positive attitude towards conservation, if switching costs do not increase significantly with the level of conservation, and conservation reduces input use.

In summary, there will be three types of farmer:

1 **Type 1** are those farmers with negative attitudes towards conservation (i.e. $\frac{\partial U}{\partial Opt} < 0$) who are likely not to participate, unless (unlikely) gains in productivity outweigh the costs of optimisation (the disbenefit from participation).
2 **Type 2** will be those farmers with positive attitudes towards conservation ($\frac{\partial U}{\partial Opt} > 0$), but for whom switching costs and other production impairments become obstacles. They are likely to participate in a ‘compromise regime’ where they negotiate the level of conservation down until changes in marginal costs and benefits balance the utility gain from conservation.
3 **Type 3** will be farmers with $\frac{\partial U}{\partial Opt} > 0$ and $\frac{\partial T}{\partial X} < 0$. If anything, these farmers benefit twofold from participation, both from a personal as well as from a business perspective. It is therefore likely that these farmers participate in optimal measures.

3.2. Empirical model for grassland optimisation

To estimate farmers’ choices, we apply random utility theory. Farmers face a choice among several alternatives, including non-participation, a compromise alternative, and an optimal grassland regime. The utility (U) maximisation principle assumes that a farmer will agree to a proposed policy alternative i over alternative j if $U_i > U_j$. Because utility is an ordinal concept, the standard approach in the literature is to model choices probabilistically, i.e. $\Pr(U_i > U_j)$ is the probability of choosing option i over option j (Train, 2009). In random utility theory, it is assumed that utility is the sum of a deterministic, observable term V and a random term ε unobservable to the researcher, but known by the decision maker. The probability of choosing alternative i *over* j can therefore be expressed as $\Pr(V_i + \varepsilon_i > V_j + \varepsilon_j)$. This expression requires assumptions about (1) the *functional form* and the components of the deterministic utility function, and (2) the *distribution of the error term*. A convenient expression of the deterministic part V is the linear additive form that sums up the characteristics of the choice in addition to the characteristics of the farmer, each weighted by their respective marginal part-worth utilities β_i (Lancaster, 1966).

$$U_{ij} = \beta_i X_{ij} + \varepsilon_{ij} \tag{5}$$

Given the categorical choice, assuming an extreme value type 1 distribution of the error term leads to a simple multinomial logit (MNL) model to describe the probability of choosing a given alternative (Train, 2009).

The probability of choosing a compromise alternative C is $\Pr(C) = \frac{e^{V_C}}{1 + e^{V_C} + e^{V_F}}$, and the probability of a full commitment F is $\Pr(F) = \frac{e^{V_F}}{1 + e^{V_C} + e^{V_F}}$. The probability of not participating is therefore $\Pr(N) = \frac{1}{1 + e^{V_C} + e^{V_F}}$. The parameters β_i were estimated by maximum likelihood (e.g. Wooldridge, 2009) in STATA version 13. As is standard in MNL models, the utility of not participating is normalized to zero, so all estimated parameters are interpreted as marginal utilities relative to choosing not to participate.

3.3. Data

The data were collected between 2004 and 2011 in 17 MaPs in Saxony. The interviews were part of the MaP-process. Farmers contact details were provided by the local authorities. We contacted all known and available farmers using grassland, which was identified as habitat type, and conducted interviews with those 131 farmers who agreed to be interviewed. It is noteworthy, that even farmers with a critical perception on nature conservation, were willing to participate, less than ten farmers denied an interview. We developed a questionnaire comprised of 12 questions regarding their land-use practices on grassland. In total, we compiled data on 333 specific grassland plots (habitat types) in Western and Central Saxony. During the interview, farmers were asked about their actual land-use practices on grassland. Through these interviews, information of 131 farms and 333 sites being identified as ‘habitat type’ in West and Central Saxony were collected. The characteristics of different farm-groups according to legal form are presented in Table 2.

Single full-time farms are more affected by MaP-measures, since

Table 2
Structural elements of the interviewed farms.

Legal form	Unit	Farm size [ha]	Grassland-share [%]	Impact of habitat types	
				Habitat types [ha]	Share habitat types to total grassland[%]
Single farms	mean	23.5	77,3	3.69	26.5
Part-time (n = 42)	min–max	0.8–68.5	8.6–100	0.08–39.1	0.4–93.2
Single farms	mean	167.8	47.3	7.23	17.7
Full-time (n = 47)	min–max	8.0–600	5.0–100	0.04–59.9	0.2–100.0
Civil law associations (n = 8)	mean	438.7	35.7	4.61	8.0
	min–max	24–852	7.2–100	0.1–11.7	0.2–23.8
Limited liability & private company (n = 17)	mean	812.0	42.8	3.80	4.3
	min–max	55–2,000	5.0–100	0,2–11.3	0.1–12.8
Cooperatives (n = 17)	mean	1,357.9	29.9	6.48	3.6
	min–max	296–2,122	4.6–100	0.2–21.9	0.03–19.4

Source: own calculation based on 131 farms.

MaP-measures account (on average) for about 7 ha and 17.7% of their grassland area. Within the group of part-time farmers, the share of habitat types to total grassland is higher at 26.5%, which highlights the importance of part-time farms for nature conservation. The dual structure of East-German agriculture can also be seen in this data set: The large farms (Cooperatives, civil-law associations and large private companies) have a lower share of their area designated as habitat types (3.6%, 4.3% and 8.0%). Still, the area of habitat types for these types of farms is largest in absolute terms.

Overall, about 63% of farms were willing to adjust their grassland use for the purposes of the Habitats Directive. Another 20% of farms were willing to accept measures, which consist of compromise regimes. This seems to be very high, especially considering that about 43% of farms are not using any sort of agri-environmental programme. However, there might be some kind of 'pre-selection effect' within the planning process and the respective dataset: The habitat types within the SAC are selected by documenting the biodiversity of all grassland within the project area. In many cases, this identification is already based on a rather extensive grassland use, which allows different plant species to exist. However, in some cases, this pattern was not present, and it was not possible, to clearly identify such a pre-selection pattern.

Besides this, the data selection is typical for an investigation of management plans in Saxony, since the distribution of interviewed farmers covers the typical regions within Central and Western Saxony (see Fig. 4):

The farms are distributed throughout all the different geographic regions in Saxony, in the productive flatlands around Leipzig, the hilly regions and river-valleys of central Saxony and finally the hilly region of the 'Erzgebirge'. For the descriptive statistics of the utilised variables see Table A2. The data set also contains some site-specific information about the habitat type. These data contain information such as which habitat is recorded in the plan (e.g. highland hay meadow), the quality of biodiversity on the site (quality A, B, C), the location and size of the plot and the implemented agri-environmental programme. The decision pattern is documented in the following Table 3:

Table 3
Number of plots signed into MaP-measures by farmer's previous participation in Agri-environmental programmes (AEP) in the dataset.

	No optimisation	Compromise	Full commitment
No AEP	44	29	70
Light green AEPs	13	25	44
Dark green AEPs	6	13	68
Organic farming AEP	2	3	16

Source: own calculations; number of plots = 333.

4. Results

We estimated a simple multinomial logit model to explain which factors of farms and grassland plots are associated with participation in a 'compromise regime' or with 'full commitment'. Parameter estimates at the plot level are presented in Table 4.

The share of true predictions with 65% is acceptable, also given the restricted set of potential determinants of choices (Morey et al., 2002). The results show diverse effects: The changes in farming practices is the main determinant of farmers decisions to agree or not agree to the proposed measures. Any change of practice (all other factors kept equal) will reduce the probability of farmers to agree to the proposed measures, for either a full commitment or compromise regime. The estimated effect is more pronounced for the optimised regime, since it involves more changes.

If a grassland site is rated as a 'development plot', i.e. a grassland plot with the potential to comply with the Habitats Directive, farmers are more reluctant to agree to measures.

A farmer is more likely to choose a compromise regime for a grassland plot the steeper the slope of the grassland plot. An increase of

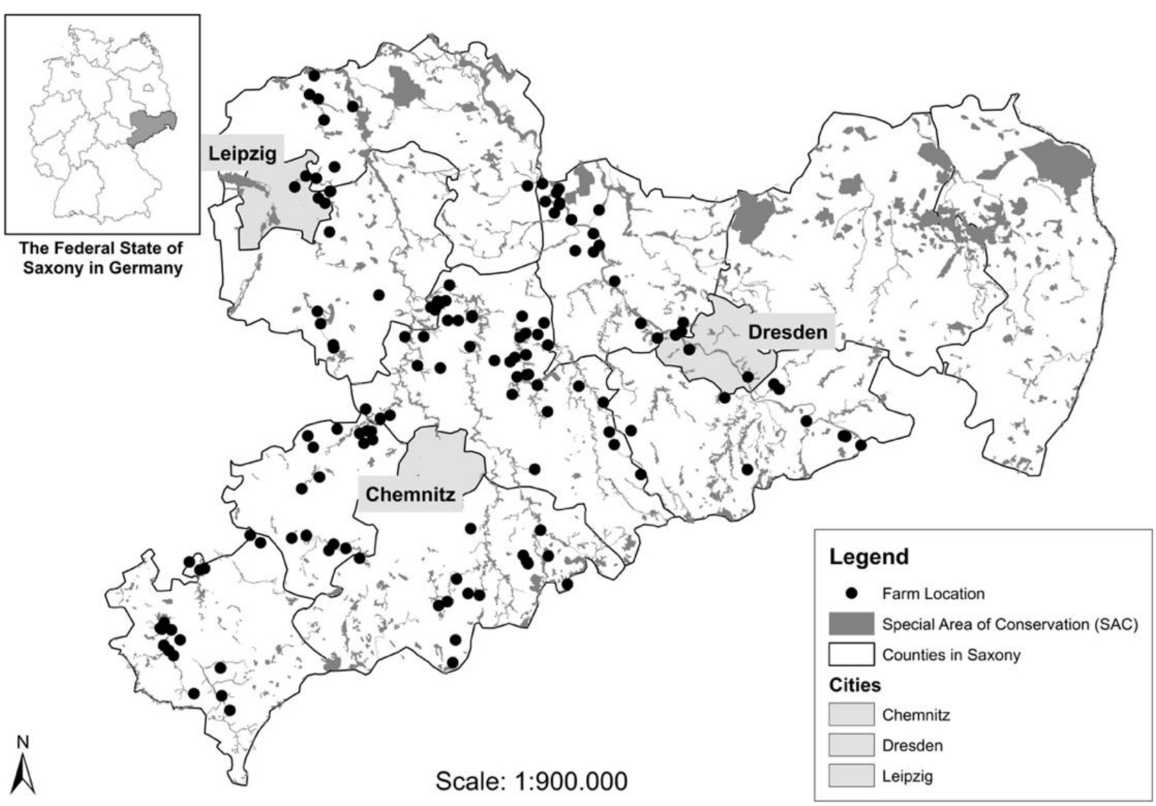

Fig. 4. The location of the interviewed farms in Saxony 2003–2011 Source: own elaboration; Note: The shape file for the SACs in Saxony is provided by the Saxony State Office for Environment, Agriculture and Geology (LFULG).

Table 4
Estimated coefficients of the multinomial logit model relating participation in management measures to farm and plot characteristics[6].

Variable	Coefficient	z-value	P > |z|	Coefficient	z-value	P > |z|
	Compromise regime (n = 70)[1]			**Full commitment** (n = 198)[2]		
Constant	1.5417***	1.67	0.095	4.5366***	5.25	0.000
Change of practice	−1.5515***	−1.82	0.068	−3.8113***	−4.83	0.000
Development plot[3]	−0.9007***	−1.97	0.049	*−0.5350 n.s.*	*−1.36*	*0.173*
Slope of the grassland plot	0.0410***	2.02	0.043	*−0.0200 n.s.*	*−0.98*	*0.328*
Distance SCI-plot to farm	−0.1326***	−3.49	0.000	−0.0853***	−2.67	0.008
Dark green AEPs[4]	1.3487***	2.05	0.040	1.1144***	1.82	0.069
Light green AEPs[5]	0.9816***	2.24	0.025	*0.5471 n.s.*	*1.31*	*0.189*
Organic farming AEP	*0.2297 n.s.*	*0.23*	*0.815*	1.5271***	1.87	0.061
Number of observations	333					
LR chi²(14)	143.2					
Probability > chi²	0.00					
Log likelihood value	−246.71					
Share of true predictions	0.6487					

Source: own calculations; n = 333; **Reference alternative** is 'no optimization' with n = 65; **1: 'Compromise regime'** describes an implementation acceptable for farm practice but still enough to maintain or improve the conservation status. **2: 'full commitment'** describes a 100% implementation of a measures proposed in the management plan. **3: Development plot** are plots that currently do not comply with the requirements of the Habitats Directive but have the potential to do so given appropriate conservation measures. **4: Dark green AEP** is a complex measure with a higher payment-level. **5: Light green AEP** is a simply, entry-type of measure, however with a lower payment level. **6:** Marginal Values are in Table A3.

1% at the sample mean (a slope of 10.5%) increases the probability to implement a compromise regime by 0.9% (Marginal values are presented in Table A3). Based on the interviews, this was often the case on steeper grassland with grazing animals, where the grazing (in contrast to a two-cut regime) is not regarded as appropriate from a conservation perspective. Grazing was often regarded as technically more feasible on steeper slopes, consequently, this factor does not influence the decision in favour of a full commitment.

The distance from the SCI-plot to the farm exhibits a negative influence on implementation in both 'compromise regimes' and 'full commitment'. Farmers seem to avoid complex production restrictions on more distant plots, often just to avoid high transportation costs of machinery.

Agri-environmental programs are increasing the willingness of farmers to change their grassland use with respect to conservation targets.

- Previous participation in a dark green AEPs (involving complex measures and higher payments) increase the probability of a change in grassland use for both compromise regimes and full commitment. In both regimes, the coefficients suggest a strong influence on the decision pattern.
- The light green AEPs (involving simple measures and low payments) also incentivise the implementation of compromise regimes, however with less influence. They do not contribute to the implementation of an optimal regime.
- Organic farming AEP support only shows a significant positive effect for a full commitment.

This is consistent with the impressions gained during the farm visits within the management plans: particularly the farmers already implementing dark green programs were constructive during the talks about the implementation of Habitats Directive, therefore this result is reflected in the management plans.

To understand the determinants of participating in an AEP, we ran another MNL model at the plot level, however relating participation in light or dark green AEPs to various farm characteristics in order to better capture effects of farm characteristics (Table 5; base category was 'no participation in any AEP').

With a given choice of three alternatives, the share of true predictions (61%) seems acceptable, since a number of potential determinants of AEP adoption were not recorded during the interviews (as e.g. in Lambert et al., 2007) and therefore not included into the model. The table shows that farm size, part time farming and a high share of grassland increase the probability of a farm participating in light green programs. In particular, the first finding can be explained by the flexibility given to large farms: light green programs often apply to the whole farm, however with somewhat lower requirements and lower payment rates. It seems quite intuitive that large farms are inclined to participate due to their higher land endowments.

Since dark green programs are linked to higher requirements, higher payment rates and specific regulations, it is clear that the land endowment is not a crucial factor here. Share of grassland is positively correlated with both light green and dark green measures.

The livestock density is only negatively correlated with participation in dark green programs. A higher livestock density indicates higher land use intensity. Farms with large herd sizes need to use grassland intensively to produce fodder. These farms are therefore less willing to use grassland less extensively and apply conservation measures. High-level conservation therefore requires enough land and a lower ex-ante land use intensity.

5. Discussion

As a general observation, the need for changing farming practices reduces the probability for farmers to implement the measures suggested by the management plans (MaP). Confirming the theory of path dependencies of agricultural practices (Vuillot et al., 2016), any option to implement MaP within existing production systems increases the potential for adoption. In many cases (39% of the plots), grassland management was already targeted towards achieving conservation targets, as it was for instance supported by a (dark green) AEP programme or simply in the farmers interest without remuneration. In this sense, MaPs offer the opportunity to first explore existing practices on the specific grassland plot, before trying to introduce standardised AEPs. This way, AEPs are designed to focus on the ecological and socio-economic context, which assures that both farmers' costs are met, and governmental funds are spent most efficiently. Note however, that we cannot conclude on the ecological quality followed by the MaP process.

Natural and location characteristics of the grassland plots (slope of the plot and distance plot to the farm) correlate with the probability of AEP adoption, confirming the findings by Koemle et al. (2019). Following the location theory of Johann Heinrich von Thünen, farmers produce at the location with a high yield potential and no steep slope, whereas grassland plots from the farm are used for conservation purposes (von Alvensleben, 1995). The results confirm literature finding

Table 5
Results of an MNL model estimating the determinants of participation in light green and dark green AEPs in Saxony.

Variable	Coefficient Participation light green AEP[1]	Z	P > |z|	Coefficient Participation dark green AEP[2]	Z	P > |z|
Constant	−4.8805***	−4.36	0.000	−2.4374***	−2.38	0.018
Log farm size (in ln ha)	0.5627***	3.73	0.000	*0.1927 n.s*	*1.36*	*0.175*
Part time farming (1/0)	1.3976***	2.74	0.006	*−0.0408 n.s*	*−0.08*	*0.937*
Livestock density (LU/ha)	*−0.2564 n.s*	*−0.79*	*0.432*	−1.0564***	−2.86	0.004
Share grassland	1.7365***	3.41	0.001	2.1788***	4.32	0.000
Number of observations	316					
LR chi^2 (8)	43.09					
Probability > chi^2	0.00					
Log likelihood	298.62					
Share of true predictions	0.6139					

Source: own calculations at plot level; The base category for both groups is 'no participation'.
1: Light green AEP is a simple, entry-type measure, however with a lower payment level. **2: Dark green AEP** is a complex measure with a higher payment-level.
3:LU = Livestock Units.

that high production potential, high land prices and less mountainous farmland reduce the probability of AEP implementation. For a similar reason, a higher distance from SCI-plot to the farm reduces the probability to adopt both, the compromise regime and the full commitment to conservation practices. Coming back to the theoretical model, mowing distant grassland would increase the costs, resulting in a lower willingness to implement.

The assessed ecological quality did not significantly affect farmers' decisions. It remains to be assessed, if after farmer training and/or the demonstration of ecological effects, the positive correlation reported in literature could be confirmed. Adding to this, farmers with plots with rather poor ecological quality ('development plot') are less probable to implement a full commitment regime. The reason might be twofold: on the one hand, development plots might involve more ambitious measures and substantial changes in order to reduce farming intensity, which will be a hindering factor. On the other hand, the fact that the grassland SCI-plot is not directly evaluated as a site in accordance with the Habitats Directive, already suggests a certain degree of intensive grassland use. Farmers might not be willing to give up intensively used grassland.

Financial support through AEPs increases farmers' willingness to implement measures to realize the objectives of the Habitats Directive. Any change of practice can be a general barrier for the implementation of conservation measures. The finding suggests that farmers have an interest to maintain their established farming practices. Any type of financial support has to remunerate this reluctance in adoption, which can also be found in the literature (Breustedt et al., 2013). Corrected for the potential changes of farming practice suggested by the MaPs, all types of applied AEPs influence farmers decisions, however, in different ways:

- Dark green AEPs with complex measures (e.g. late mowing, zero mineral fertilisation, see Table C1) and higher payments (250–450 EUR/ha, Table 1) positively influence farmers decisions to implement both compromise and optimal regimes. The average payment for a full commitment is 247.73 EUR/ha (see Table A1). In many cases, the program requirements were in accordance with the measures. In some cases, the proposed measures in the management plans went beyond the program requirements.
- Light green AEPs (rather simple entry type of measures with low payments of 50–200 EUR/ha, see Table 2) can support implementation, especially if there is potential for compromise regimes. The average payment for a compromise regime is about 144.33 EUR/ha (see Table A1). However, neither the characteristics of the measure, nor the amount of payment of about 50–200 EUR/ha, incentivise the targeted measures identified in MaPs.
- Organic farming AEP can has a positive effect on the adoption of optimal regimes. According to Röder et al. (2018), organic farms take an over-proportional share in conservation area. However, in our dataset only about 6.8% of the farms were organic farms, therefore, the group may be too small to draw strong conclusions on the influence of the organic farming programs on the implementation of the management plans. Based on qualitative impressions, we could state that some organic farmers have positive attitudes towards conservation objectives, however they also have high switching costs, due to the need to produce fodder on their grassland, which is a representation of 'type 2 farmers' as described in the theoretical model (see p. 11).

Economic considerations and profitability are crucial in farmers' decisions. In the absence of direct information on the profitability of single plots, we deduct profitability considerations indirectly on several levels: For a full commitment, the influence of dark green programs is stronger (keeping all other factors equal) pointing to the need to offer substantially higher payments to implement optimal measures within the management plans. Only if grassland is sufficiently available on a farm, i.e. implying a rather large farm size, farmers can spare some of the less productive grassland, instead of using the last hectare for producing fodder. This is specifically relevant for some of the organic farms, as they are restricted in purchasing feedstuffs from other farms. Finally, a high livestock density as indicator for intensity, negatively correlates with a successful implementation of dark green programs. In these cases, a high farm intensity (as livestock density), which can be connected to a higher potential profitability per hectare or higher opportunity costs, reduces the probability of farmers to implement conservation measures.

Financial gain may only be one of several objectives in the farmer's utility function. One might expect that farmers with high appreciation of nature would participate in a 'dark green' program, while farmers with a primary focus on profits would participate in a 'light green' program. Nevertheless, farmers who participate in an AEP may already be familiar with the bureaucracy involved, and therefore have a lower threshold towards accepting additional measures.

Overall, the interlinkages between AEPs and the implementation of the Habitat Directive in Saxony correlate positively. However, payment rates of dark-green programs seem to make a difference for the implementation of a full consent and for the willingness to cooperate in general. The findings are consistent with the literature, as Breustedt et al. (2013) find a willingness to avoid conservation measures. AEP need to sufficiently remunerate the costs of extensive grassland use (Lakner and Oppermann, 2018). On the other hand, overcomplex regulations can be identified as major obstacle to implement agri-environmental measures in general (Schüler et al., 2018; Zinngrebe et al., 2017). Consequently, program simplification might help (WBAE, 2019), as well as higher payments for dark green measures providing higher incentives for program participation (Lakner and Oppermann, 2018).

The second part of the results allows some moderate conclusions on how to enhance farmers participation in AEP:

Farm size correlates with increased AEP participation, particularly with respect to light green measures. In a model with farm level indicators, larger farms increase the probability of implementation of both compromise and optimal regime (see Table 5). This finding is consistent with many other studies (Damianos and Giannakopoulos, 2002; Ruto and Garrod, 2009; Vanslembrouck et al., 2002; Zimmermann and Britz, 2016). It should be noted that Mann (2005) finds smaller farms more willing to participate in AEPs in Switzerland. Higher probabilities to implement environmental measures can be also related to higher levels of education and awareness of the benefits for production. While small farms are restricted in their flexibilities due to scarcity of land, a stronger and accessible knowledge base of innovative, location-based solutions (and their documented success stories) might offer new possibilities to smaller farmers.

As general farm characteristics, part time farmers tend to participate in light green AEPs. Existing studies explain this through a lower dependency on income from production. Another explanation can be time constraints, since entry type of programs impose less restrictions, whereas dark green programs might be too restrictive for part-time farmers. Intensity of farming seems to divide farmers into ideological groups, the ones striving for maximum productivity and the ones envisioning cultural landscapes (Kvakkestad et al., 2015).

Complementary to the incentives of AEPs to the implementation of the Habitats Directive, the positive effect also accounts vice-versa. The results document how management plans can support AEPs through participatory processes, communication and consultation. In Saxony, this method also had a motivating impact: On average, farmers on 59% of all investigated SCI-plots agreed to execute an optimal grassland-regime (‘full commitment’), ranging from 40% to 86% depending from the specific management plan (see figure 5 in appendix 1). Another 24% of the sites were managed with a regime which included a compromise with the farmer (‘compromise regime’). This confirms literature in highlighting the need for moderated, participatory processes for successful implementation of farmland conservation measures (Buizer et al., 2016; Persson et al., 2016).

The study has a number of limitations: The dataset was taken from 17 management plans in Western and Central Saxony. Parts of Saxony are not included in the study. The specific results give some interesting insights in the implementation of the Habitat Directive in Saxony; however, the findings might not be representative for all farms in Saxony being subject to measures of the Habitats Directive, since this (to our best knowledge) has not yet been investigated. Furthermore, the long time period from 2004 to 2011 might slightly affect farmers' behaviour, since at the beginning the system of management plans was unknown, whereas at the end, many interviewed farmers were already aware of it. However, we could not find a systematic dynamic trend over time within the data set. The findings are specific for the willingness to adjust their grassland use and thereby go beyond the participation literature within AEPs. The focus of this study lies on the conservation of high nature value (HNV) grassland and cannot be generalized for all type of farms. Therefore, results have to be treated with caution with regards to other regions and other types of land use.

6. Conclusions and policy implications

Management plans (MaPs) are a tool for implementing the conservation of biodiversity-rich grassland as defined by the EU's Habitats Directive. The objective of the Habitats Directive is to create a ‘*coherent European ecological network*’ for fauna, flora and habitats, together with the Birds Directive. The MaPs are not directly linked to the classical AEPs, since both policies are managed by different administrative areas within the EU (DG Agri and DG Environment) as well as in nationally implementing agencies. Nevertheless, in this study we show how both policies jointly increase the willingness of farmers to engage in conservation. Having been the second largest provider of funding for nature conservation in Germany (Güthler and Orlich, 2009: p.134), Saxony has contributed to a significant innovation in the application of two central EU conservation policies. The documentation of the synergistic implementation of AEPs and participatory process accompanying the development management plans sheds light on the factors motivating farmers willingness to engage in conservation practices.

Our study reveals some facilitators and barriers for the implementation of conservation practices on grassland: The results show that a high animal density (i.e. a higher value added and therefore higher opportunity costs per hectare) are negatively correlated with the farmers willingness to implement. Furthermore, the specific land endowment on a farm can strongly restrict the options for farmers, to use some of the grassland extensively. On the contrary, it is plausible to assume, that perception of conservation practices and also education exhibit a positive influence on the implementation of conservation measures. This is assumed in our theoretical model and which remained as qualitative impression from the interviews, however, we do not directly test this in our model. Finally, there are no indications of ecological quality influencing farmer decisions. Overall and in accordance with existing findings e.g. Breustedt et al. (2013), the level of payments is a crucial factor in implementing conservation.

In general, the complementary implementation of the Habitat Directive and voluntary AEPs bear considerable potential to incentivise conservation practices on grassland, beyond the case of Saxony. The instrument of MaPs can also be used to discover the barriers to implementation, since farmers usually state why they might not be willing to implement or optimise their grassland regime. A voluntary implementation of the Habitats Directive through AEP can lead to an impact on biodiversity without having to amend the Habitats Directive (Hochkirch et al., 2012; Maes et al., 2013). The results show how the implementation of the Habitat Directive can be supported by focussed, well paid AEPs as a coherent incentive for farmers. Extension services focussed on biodiversity can support the maintenance of ecological quality and help to raise farmers awareness (Oppermann et al., 2018).

Experiences with ‘payments for ecosystem services’ in both, developed and developing countries show that often political power struggles and administrative burdens undermine effectiveness and sustainability of incentive systems and that policies are lacking long-term perspectives (Wunder et al., 2008). In this wider context, the system of management plans in the Habitats Directive can be regarded as an instrument to tackle long-term challenges. However, the model results suggest, that this instrument works only if payments schemes for ecosystem services are adjusted towards the specific conservation management suggested in the management plans.

Beyond the acceptance of the instrument MaP by farmers and the voluntary implementation in Saxony, it needs to be further investigated, to what extent the voluntary implementation can lead to ecological improvement following the process of the MaPs. Despite the potential on the *farming side*, to overcome barriers, which we could show in this paper, it remains still subject for future research, to investigate the *ecological quality* of this voluntary approach in Saxony, after having finalized the MaPs in 2012. After having announced the willingness to adjust farming practices, it remains the task of state authorities to harness this potential and to make sure that species and habitats can be maintained. In general, the Habitat Directive has the potential to protect and maintain farm-biodiversity (Pellissier et al., 2019).

However, the third national report in Germany on the Habitats Directive suggests, that the conservation status of biotopes and species is further deteriorating (BMU, 2019). For Saxony, the share of biotopes with an ‘*unfavourable status*’ has increased from 62% in 2013 to 72% in 2018. Especially the habitat ‘lowland hay meadow’ (No. 6510, being the most relevant habitat for grassland), turned form ‘*favourable’* (2013) to ‘*unfavourable-inadequate*’ (2018) (SMUL, 2019), suggesting a deterioration of this habitat type in the region. The state of Saxony has reacted by creating capacities for consultation services (Offices for conservation practice, 'Naturschutzstation') (BfN, 2019), which however, seems to be still insufficient to improve the overall status of the SAC-plots in Saxony. The management plans can only highlight the long-term potential to implement AEPs and optimize grassland use in terms of conservation objectives, however the implementation remains to be realized by the state authorities.

Finally, the selection of biodiversity measures in the 2014–2020 CAP period and the EU Commission's proposal for a post-2020 CAP disregard the potential of an integrated policy approach as scientifically supported by this paper and others (Pe'er et al., 2019). The 2014–2020 CAP has focused the biodiversity funding on greening, being coupled to direct payments (EU Commission, 2011b), which has been criticised for its low effectiveness in protecting biodiversity (Hart and Little, 2012; Pe'er et al., 2014, 2017). By contrast, the EU's biodiversity strategy 2020 asks to fully implement the Birds and Habitats Directive (target 1) and for agriculture to stronger contribute to biodiversity conservation (EU Commission, 2011a). As the current proposal for the CAP post 2020 calls for member states to design the new 'Eco-schemes' and the established and co-funded AEPs, it deems necessary to strengthen targeted payment schemes for grasslands. The implementation of the CAP post 2020 will play a key role in improving conservation performance in agricultural landscapes. In the light of the current infringement process against Germany (Anonymus, 2019), a better integration with CAP instruments and a locally moderated, contextualised implementation of the Habitats Directive may lead to better policy results for both, the EU's post-2020 biodiversity strategy and the Common Agricultural Policy (CAP).

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Appendix A. Additional Data and Results

Fig. A1

Table A1
Average payment for farmers implementing management plans.

Decision for MaP-measures	Average payment (EUR/ha)
No optimization	66.54
Compromise regime	144.33
Full commitment	247.73

Source: own calculation, n = 333.

Table A2
Description of the farm- and plot-specific variables for the multinomial logit model.

Variable	Unit	Mean	sd	Min	Max
Farm level (n = 131)					
Log of farm size	[In ha]	5.01	1.75	−0.22	8.11
Part time farm	1/0	0.29	0.45	0	1
Single farm	1/0	0.34	0.47	0	1
Partnership under civil law (GbR)	1/0	0.07	0.25	0	1
Cooperative (e.G.)	1/0	0.15	0.36	0	1
Limited liability company (GmbH)	1/0	0.14	0.35	0	1
Livestock density	[LU/ha]	0.72	0.57	0.00	1.12
Share grassland	share	0.52	0.35	0.05	1
Plot level (n = 333)					
No optimization	1/0	0.20	0.40	0	1
Compromise regime	1/0	0.21	0.41	0	1
Full commitment	1/0	0.59	0.49	0	1
Change of practice	1/0	0.61	0.49	0	1
Quality A (=high)	1/0	0.08	0.26	0	1
Quality B (=medium)	1/0	0.53	0.5	0	1
Quality C (=low)	1/0	0.19	0.39	0	1
'Development-plot'	1/0	0.20	0.40	0	1
Slope of the grassland plot	%	10.56	9.69	0	45.9
Altitude of the SCI-plot	meters	312	261.87	85	1134
Distance SCI-plot to farm	km	5.86	6.39	0.08	30.2
No AEP participation	1/0	0.49	0.50	0	1
Dark green AEPs	1/0	0.26	0.44	0	1
Light green AEPs	1/0	0.25	0.43	0	1
Organic farming AEP	1/0	0.06	0.24	0	1

Source: own calculations; **Note:** Explanations of the agri-environmental programmes (AEPs) are provided in Table 1.

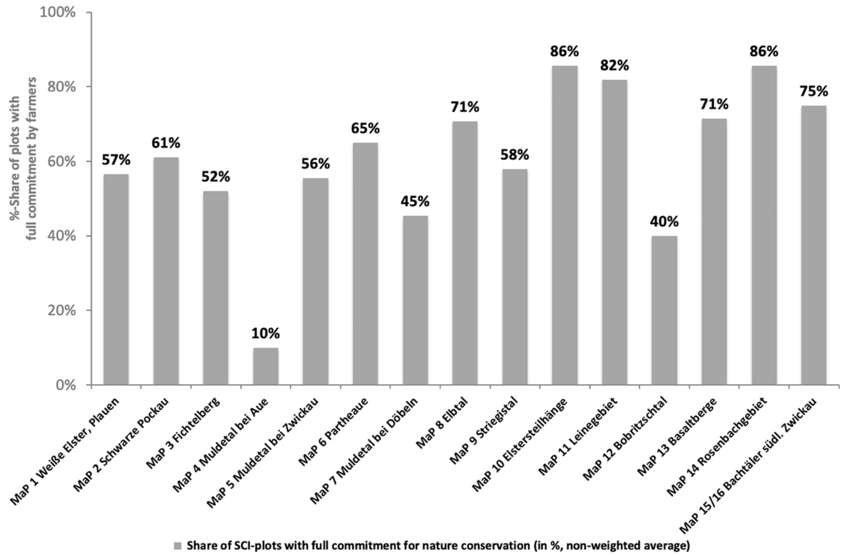

Fig. A1. Share of SCI-plots with full commitment of the farmers due to nature conservation according the management plans (in %, non-weighted average) Source: own calculations; Note: We aggregated the management plans 4 and 5 and 15 and 16.

Table A3
Marginal effects at the sample mean estimated from the model presented in Table 5.

	Mean	No optimization			Compromise regime			Full Commitment		
		M.E.	Std. Err	p-value	M.E.	Std. Err	p-value	M.E.	Std. Err	p-value
Change of practice	0.607	0.301	0.046	0.000	0.286	0.061	0.000	−0.586	0.074	0.000
Development plot	0.198	0.056	0.035	0.112	−0.070	0.066	0.289	0.014	0.075	0.858
Slope of the grassland	10.561	0.001	0.002	0.740	0.009	0.003	0.000	−0.010	0.003	0.002
Distance SCI-plot - farm	5.860	0.009	0.003	0.004	−0.009	0.005	0.061	0.001	0.006	0.913
Dark green AEPs	0.261	−0.106	0.056	0.057	0.060	0.075	0.424	0.046	0.092	0.617
Light green AEPs	0.246	−0.059	0.037	0.117	0.081	0.057	0.157	−0.022	0.070	0.750
Organic farming AEP	0.063	−0.113	0.076	0.140	−0.177	0.115	0.124	0.290	0.128	0.023

Source: own calculations; **Note**: M.E. = marginal effect at the mean, Standard errors computed using the Delta method.

Appendix B. The procedure of identification of 'Special Areas of Conservation (SAC)'

The objective of the Habitats Directive is the protection and conservation of habitats for specific species, designated as *'Sites of Community Interest (SCI)'* in three stages (EU Commission, 2011b):

1 EU member-states propose habitats to the EU Commission according to the criteria in the Habitat Directive, which need to be supported by scientific documents (such as e.g. species lists).
2 The Commission then leads a consultation process among representatives of member states, stakeholders, and non-governmental organisations (NGOs) for e.g. environment, to determine the suitability of the proposed conservation sites. States can be directed to designate additional sites. At the end of this consultation process, the European Commission agrees to the proposed areas as SCIs. The objective of this consultation process is to ensure and maintain the '*favourable conservation status*' of the habitats or species in the respective area.
3 In the final step, member-states have to identify the necessary nature conservation or land use measures to either maintain or reach the designated conservation status within six years after the designation of the area by the EU (Article 6 (2) of the Habitats Directive). Member states are legally obliged to avoid deterioration of species and/or habitats (EU Commission, 2000: 24/25).
4 Saxony has defined regulations for basic protection of each SCI, which converts the legal status of these areas to a 'Special Area of Conservation (SACs)' and which defined general objectives to maintain the status of habitat types (annex 1 of the Habitat Directive) and species (annex 2,4,5).

Appendix C. Examples for typical measures in a management plan

We can distinguish roughly five basic types of typical measures (Table C1):

Table C1
Examples for typical measures in SCIs in Saxony (simplified).

Type of measure	Description
1. Fertilisation	Restriction of fertilisation to 60-75 [kg N/ha and year] on grassland with high yield potential and to 60-75 [kg N/ha every second or third year] on grassland with medium yield-potential, no fertilisation on grassland with low yield potential.
2. Time of mowing on grassland	Harvesting of the grassland after 15th June or at the time of flourishing of the main yield determining grassland-species, 40 days rest-period before the second cut
3. 'Glaucopsyche-regime'	Refrain from mowing grassland in between the 30th of June and the 15th of September. In this time, the flower *Sanguisorba officinalis* (Great Burnet) is flowering, which supports the red-list target species, the butterfly *Glaucopsyche nausithous* ('Dusky Large Blue') in reproduction.
4. Introduction of a mowing-regime	Mowing restrictions for grasslands without regular agricultural use, or tall forb communities. This applies particularly for grassland in semi-forest habitat conversions.
5. Cutting young wood	Cutting young trees and hedges in order to re-establish a grassland-regime. Often, there are young trees on unused grassland, which finally after some years replace blooming species on grassland and finally starting a conversion process into woodland. These bushes and trees have to be erased.

Source: own elaboration, information based on different management plans.

In contrast to the fixed dates specified for AEP implementation, management plans specify time guidelines based on the ecological dynamics of important grassland species. For example, the time of mowing should be at the time of flourishing of the most important yield enhancing grassland-species (Measure 2 in Table 9). Similarly, standards for fertiliser levels (measure 1) are defined based on grassland yield potential. Measures (4) and (5) are designed to re-establish or secure grassland use and to prevent these grassland plots from natural succession into forests. These two measures are in some cases not applicable, since they also involve investment costs and the agri-environmental programs in the financial periods 2000–2006 and 2007–2013 in Saxony do not always cover these costs.

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