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Farmers' preferences for nature conservation compensation measures with a focus on eco-accounts according to the German Nature Conservation Act

Christian Sponagel[a,*], Elisabeth Angenendt[a], Hans-Peter Piepho[b], Enno Bahrs[a]

[a] Department of Farm Management (410b), Institute of Farm Management, University of Hohenheim, Schwerzstraße 44, 70593 Stuttgart, Germany
[b] Department of Biostatistics (340c), Institute of Crop Science, University of Hohenheim, Fruhwirthstraße 23, 70599 Stuttgart, Germany

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ABSTRACT

Negative impacts on nature and landscape caused by development activity have to be offset within the framework of no-net-loss policies in many countries worldwide. In Germany this is legally anchored in the German Nature Conservation Act (BNatSchG). The relevant compensation measures or biodiversity offsets are often implemented by developers on agricultural land which is lost as a result of the offsetting activity. Therefore, conflicts of interest can arise between the actors involved. However, approaches like mitigation banking can give farmers the possibility to voluntarily carry out a compensation measure against payment by the intervener. Thus, they can control the location and type of measure themselves and counter land use by external interveners. By establishing the timing of the individual measures in advance, these can further be better planned and coordinated than before. This may also lead to greater benefits for nature conservation. Hence, we conducted a discrete choice experiment with 209 farmers at the federal level to analyse under what conditions farmers would be willing to voluntarily implement compensation measures and how acceptance could be improved. We found that farmers are generally willing to implement compensation measures. One major challenge is the form of legal protection of the measure in connection with whether the measure is permanent or only for a fixed period of time. A land register entry markedly reduces acceptance. In addition, the market value of an area and the associated potential loss of value are also relevant. Furthermore, we were able to show that, in general, farmers are most accepting of production-integrated compensation (PIC). However, we did identify a lower acceptance of PIC among organic farmers. Nevertheless, production-integrated compensation in particular, depending on the legal safeguards, can be a rather expensive alternative for the intervener who bears the costs. Hence, our analyses provide important information for policy makers in environmental legislation and for practical landscape planning and nature conservation. They likewise provide insights into the market for biodiversity offsets in Germany.

1. Introduction

1.1. Basic principle behind the Impact Mitigation Regulation in Germany and its impact on conflicting goals

The conservation of biodiversity is currently a major challenge on a global scale (Bull et al., 2013; Darbi, 2020; IPBES, 2019). Economic development, combined with infrastructure and settlement development, is one of the major causes of habitat loss and is therefore often associated with negative impacts on biodiversity and the balance of nature (Laurance et al., 2015; Lechner et al., 2018; Newbold et al., 2015; Quétier and Lavorel, 2011). To offset these interventions in nature, so-called "no-net-loss" (NNL) policies have been implemented in more than 100 countries worldwide (GIBOP, 2019). After avoiding and minimising any negative impacts on the balance of nature, offsetting is the third step in the mitigation hierarchy (Arlidge et al., 2018; Kiesecker et al., 2010). In the USA and Germany this policy approach has been anchored in environmental law since the 1970s and is of particular interest for researchers and decision makers (Bull et al., 2018). In this context, the Impact Mitigation Regulation (IMR) plays a decisive role in Germany (Albrecht et al., 2014). According to Article 13 of the German Nature Conservation Act (BNatSchG), unavoidable significant adverse effects on nature and landscape, for instance any kind of development activity, are to be offset by adequate compensation or substitution

* Corresponding author.
E-mail address: Christian.Sponagel@Uni-Hohenheim.de (C. Sponagel).

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measures. In this study, the term 'compensation measures' refers to both compensation and substitution measures.

In order to implement these compensation measures, appropriate areas will of course be required. On the basis of the following figures, it becomes clear that land use through compensation measures can also be in conflict with food supply objectives. Between 2014 and 2017, the average daily land consumption for settlement and transportation area in Germany was about 58 ha (Federal Statistical Office, 2019). In addition, land is also claimed for the corresponding nature conservation compensation measures (Steinhäußer et al., 2015). Farmland is also frequently used for this purpose and is therefore no longer available for agricultural production (Tietz et al., 2012). According to current political objectives, land consumption in Germany is to be reduced to 30 ha a day by 2030 (Die Bundesregierung, 2017). At the level of the EU28 between 2000 and 2018, 78% of the total land take, i.e. conversion of land into urban areas or sealed surfaces, involved agricultural land and about half of this involved arable land and permanent crops (EEA, 2019). The absolute loss of agricultural land between 2000 and 2017 in hectares, i.e. areas under cropland and permanent meadows or pastures, was about 0.38 million in Germany, 1.11 million in France and 0.17 million in the Netherlands, for example (FAO, 2020). Also, many other European countries have implemented a mitigation hierarchy and offsetting in spatial planning, for instance Austria, Switzerland, Sweden, the Netherlands, the United Kingdom or Spain (BfN, 2011; Wende et al., 2018). Thus, it can be assumed that there are similar conflicts between nature conservation and agriculture in these countries and that the results of our study can possibly be transferred in order to improve collaboration with farmers in the field of nature conservation. Eco-accounts constitute one way of reducing these conflicts.

1.2. *Eco-accounts within the legal framework of the Impact Mitigation Regulation in Germany*

Eco-accounts could also offer the option of planning and implementing optimally coordinated measures and subsequently selling them to an intervener, who in turn can then fulfil its legal obligation quickly and comparatively simply. Eco-accounts are intended, on the one hand, to alleviate the problem of the availability of suitable compensation areas and, on the other, to make compensation measures more effective from an ecological perspective, for instance though large scale planning and sensible coordination (Peinemann, 2016; Wende et al., 2018). For example, several small interventions can be compensated for by implementing a single large-scale measure (Mazza and Schiller, 2014). This can also increase the probability of the success of the offset project from an ecological perspective (Moreno-Mateos et al., 2012). Similar examples of such mitigation banking approaches are to be found in the United States, Australia and South Africa (Boisvert, 2015; Vaissière et al., 2017). In contrast to the German IMR, US Wetland Mitigation, for example, is already well known internationally and has been the subject of scientific research in the context of voluntary compensation measures (Darbi, 2020). Consequently, the German case of eco-accounts – as a form of mitigation banking – is briefly explained in the following.

In Germany, compensation measures can be carried out in advance and stocked for future interventions (Article 16 BNatSchG). The stocking of measures is governed by state law and is done, for instance, through eco-accounts. In the federal state of Baden-Württemberg, the assessment and stocking are governed by the Eco-Account Regulation (ÖKVO). The intervention usually leads to a downgrading of the existing biotope type and soil functions, assessed as the number of so-called ecopoints per m^2. Therefore, compensation must involve an upgrade of the biotope type or soil function at another site, ideally next to the place of intervention with at least the same number of ecopoints. Fig. 1 illustrates the position of eco-accounts within the framework of the German IMR.

A typical compensation measure can involve the conversion of arable land into grassland or the planting of woody plants (Wende et al., 2018). Production-integrated compensation (PIC), i.e. management or maintenance measures pursuant to Article 15 (3) BNatSchG on agricultural and forestry land with continued agricultural and forestry use, is intended to lead to a permanent enhancement of the natural balance or landscape on the land and aims to reduce the consumption of farmland for compensation measures. It gives farmers the opportunity to participate as active partners in nature conservation (Czybulka et al., 2012; Druckenbrod and Beckmann, 2018). PIC can be established either on arable land, for instance, through extensive crop management, flower strips, extended stubble fellow etc., or on grassland, for instance through extensive use. In our opinion PIC means the maintenance of previous land use, for instance arable land or grassland. In general, farmers can voluntarily implement compensation measures such as PIC or any other possible measure on their land. This generates a number of ecopoints which are credited to their individual eco-account, and they can then trade them freely on the market. In many federal states there are commercial compensation agencies, for instance Flächenagentur Baden--Württemberg which, in this case, may act as an intermediary between farmer and intervener. They give advice on planning the measure, completing of regulatory requirements for setting up an eco-account and mediate between suppliers and those who demand ecopoints. Thus,

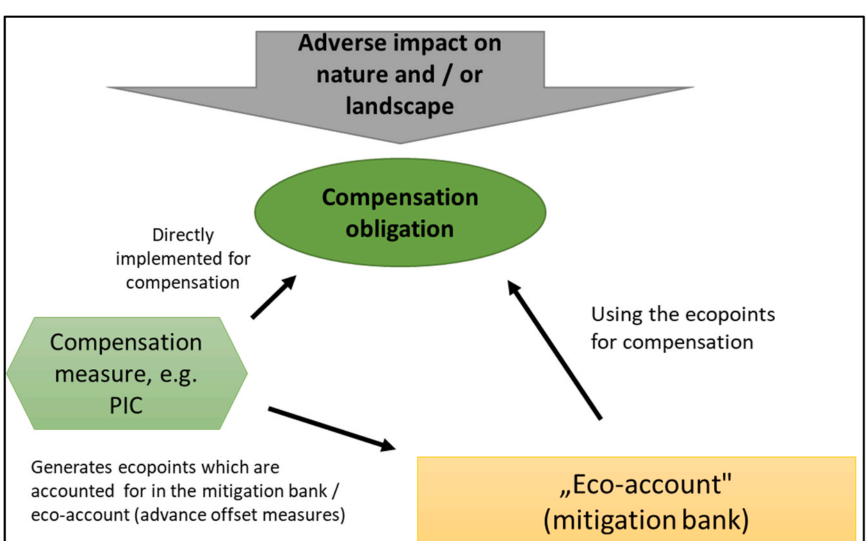

Fig. 1. Schematic representation of eco-accounts within the legal framework of the Impact Mitigation Regulation in Germany.

interveners can fulfil their compensation obligation by buying an adequate number of ecopoints. Usually, the compensation measures have to be permanent and legally protected, for instance by a land register entry (Lütkes and Ewer, 2018). If farmers generate and sell ecopoints, they are responsible for maintenance and legal protection. The maintenance period can be limited to 25–30 years if it can be assumed that the type of biotope created is itself viable (Lütkes and Ewer, 2018). In more generally terms it can be limited by the principle of proportionality (Louis, 2010). Whereas PIC is specifically addressed, for instance in the Bavarian Compensation Ordinance (BayKompV) where a certain legal framework has been established, there are no specific regulations for PIC in many other federal states. Instead of the land register entry, according to Article 9 (5) BayKompV the legal protection of the compensation measure in Bavaria might be achieved by an agreement under the law of obligations between the intervener and an institution, such as foundations, rural societies, landscape conservation associations, recognised nature conservation associations or land agencies. These institutions have then to guarantee the planning and implementation of the measures. Furthermore, under Bavarian law, for example, it is even possible to rotate the compensation measure, which means that the measure can take place on alternating parcels and be integrated into crop rotation. For PIC on alternating plots, the maintenance period is generally limited to 25 years, for instance under the BayKompV. In practice, after the maintenance period, another area with an already high nature conservation value can be permanently secured by an entry in the land register. No further maintenance is then required of this area. This takes into account the legal requirement of the necessary permanence of the measure (Himmler, 2014). In Baden-Württemberg, for example, PIC is not mentioned in the ÖKVO. According to the ÖKVO, it is only the target condition or the intended biotope type that is important for the assessment of the measure, no matter how this is achieved. Therefore, PIC is just one possible option for creating a certain kind of biotope. From the perspective of agricultural policy, measures such as PIC and even the complete transfer to nature protection can also be compatible with the application for direct payments of the Common Agricultural Policy (CAP) of the European Union (European Court of Justice (ECJ) (2010)). According to Article 16 (3) BNatSchG there must not be any other legal obligation to conduct compensation measures, i.e. they are not compatible with greening and agri-environmental measures of the second pillar of the CAP. Compensation measures and agri-environmental measures are actually comparable with regard to the nature and management of the measures. Nevertheless, especially the contractual framework conditions (e.g. the intervener as the contractual partner) differ, which can also impact relative acceptance (Le Coent et al., 2017). The comparability of this study with other analytical results on agri-environmental measures is therefore limited. In addition, contracts for agri-environmental measures usually have a five-year term. In the context of compensation under nature conservation law, permanent upgrading must be carried out. From a nature conservation point of view, however, the short contract term in the design of agri-environmental measures is also discussed critically (Engel, 2015). Compensation measures would resolve this issue. However, compensation measures such as PIC are not widely established at the present time and the legal framework is under development (Druckenbrod and Beckmann, 2018). From a nature conservation perspective, PIC is also critically discussed because – as a form of extensive land use – these measures do not necessarily create a stable habitat or ecosystem (Hey, 2010). Nevertheless, priority should be given to cultivation or management measures when agricultural areas are used for nature conservation compensation in accordance with Article 15 (3) BNatSchG. After all, agricultural land plays a key role in nature conservation simply because of its substantial share in the landscape (Bennet et al., 2006). Moreover, extensification of agricultural use is almost inevitable from the perspective of biodiversity conservation in general (Meyer et al., 2013). PIC can be targeted at a variety of field species or habitats, for instance arable wild herbs or farmland birds (Czybulka et al., 2012; Druckenbrod and Beckmann, 2018). In this respect, concepts such as PIC should also be examined more closely in the context of IMR.

1.3. *The goal of our study and hypotheses*

We assume that the implementation of compensation measures on farmland is often associated with a loss of productive agricultural area, especially because interveners might purchase the land to fulfil their offset obligations. This can lead to small, isolated and randomly distributed measures with possibly lower value for nature conservation than PIC. In addition, one logical result is a significant loss of income for the farmers. According to a local case study in Baden-Württemberg by Rabenschlag et al. (2019), the degree of implementation of compensation measures was just about 68%. Thus, they concluded that there are significant deficits in the implementation of nature conservation compensation measures in Germany. For this reason, there could also be potential for synergies between nature conservation and agriculture if farmers were to act as service providers for the implementation of the measures. Especially in densely populated areas with major land consumption by settlement and infrastructure, there might be huge competition between different land uses and hence conflicts might arise (Steinhäußer et al., 2015). One such example is the Stuttgart Region (www.region-stuttgart.de). A nationwide comparison revealed that the Stuttgart Region is one of the strongest economic locations in Germany and the number of gainfully employed people has been growing steadily for more than two decades (Dispan et al., 2019). In conclusion, extensive development activity also leads to a high demand for compensation sites and conflicts with agriculture are unavoidable. If farmers are willing to conduct compensation measures voluntarily and sell the ecopoints to interveners, this would give them an opportunity not only to control the type and location of a compensation measure, but also to participate monetarily. Moreover, well-coordinated and possibly interrelated measures could lead to better nature conservation. This might give farmers an opportunity to become active partners in nature conservation and improve their image. Sattler and Nagel (2010) found that acceptance of nature protection and environmental conservation measures is not primarily driven by monetary aspects. Effects like enhanced image in society can also be quite important and might lead to a general acceptance of voluntary compensation measures.

Our goal was to determine the acceptance of exemplary voluntary nature conservation compensation measures among farmers in the context of eco-accounts. To this end, acceptance can be analysed both in non-monetary terms as well as in terms of monetary units. For an assessment in monetary terms, we conducted a discrete choice experiment (DCE) in Germany with a special focus on the Stuttgart Region to understand farmers' preferences for compensation measures. In the DCE the respondents could choose between two compensation measures and the status quo, i.e. not implementing any measure. Each hypothetical compensation measure was characterised by a set of attributes. Our study was motivated by the objective of analysing and resolving conflicts between farming and nature conservation. With regard to the acceptance of compensation measures by farmers, many influencing factors are conceivable. According to Sattler and Nagel (2010) farmers' acceptance of nature and environmental conservation measures is not just driven primarily by monetary aspects. Effects like image enhancement in society might be quite important, and compensation measures could therefore also enable farmers to be an active partner in nature conservation. In this context, farmers may also see a benefit for themselves from the implementation of compensation measures. With regard to long-term commitment to certain production processes, similar studies found that the contract term also impacted acceptance (Gillich et al., 2019; Santos et al., 2015). This aspect could therefore be relevant for compensation measures, too. In the urban district of Stuttgart itself, the average farm size is just over 13 ha which is much smaller than the average in the whole of Baden-Württemberg of around 35 ha

(Statistisches Landesamt Baden-Württemberg, 2016). Thus, the take up of farmland might be crucial for these rather small farms. Similarly, farms with a high value-added on the land can be severely affected economically. Therefore, it can be assumed that these farmers might demonstrate a relatively low acceptance for compensation measures. In addition, Lastra-Bravo et al. (2015) and Science for Environment Policy (2017) showed that farmers might be less willing to accept long-term contracts for agri-environmental measures when the farm has a successor. This attitude might also apply to compensation measures. Furthermore, it can be assumed that a land register entry also impacts the market value of the land, because this is usually valid in perpetuity. This means that the land can actually never be used for other purposes. According to Lehn and Bahrs (2018) and Mährlein and Jaborg (2015), the mere inclusion of farmland in protected areas for nature conservation purposes, for instance in Natura 2000, can lead to a drop in market value. Mährlein and Jaborg (2015) estimate the minimum decrease to be at least 15–20%, independent of any management requirements. In addition, there might be a speculation component (Mährlein and Jaborg, 2015) anticipating possible future increases in market value, resulting, for instance, from conversion into building land, etc. Nevertheless, there might still be a possibility that even compensation sites can be used for a new impact on nature, which results in an even greater need for compensation (Federal Administrative Court, 2006; German Bundestag, 2018). This might be especially the case in densely populated areas with extensive development and building activity. Therefore, the individual level of information of the legal background can also be important when deciding to implement a compensation measure and farmers might not always be well informed about the legal framework of the subject matter (Vaissière et al., 2018). Busse et al. (2019) demonstrated that a required entry in the land register significantly reduces the willingness of land owners to implement nature conservation compensation measures, i.e. enhancement of wetland meadows in this case. Against this backdrop we advance the following hypotheses:

H1. : In general, farmers are willing to implement compensation measures on a voluntary basis; however, the type and design of the measure have an impact on the willingness to accept such measures.

H2. : Decreasing farm size and an increasing share of high value-added special crops in the crop rotation lead to lower acceptance of compensation measures.

H3. : The requirement of entry in the land register to legally secure the compensation measure reduces acceptance.

H4. : The duration of the officially defined maintenance and cultivation period has a major impact on acceptance.

H5. : In urban areas like the Stuttgart Region with a high amount of land consumption, farmers are less willing to implement compensation measures in comparison to other regions. In addition, the standard land values of the agricultural land are relevant.

H6. : Farmers decide significantly differently if they are better informed about the consequences of securing compensation measures in the land register and other relevant legal requirements.

H7. : Compensation measures are less accepted when a farm has a successor.

The analysis allows us to estimate the willingness to accept (WTA) compensation measures under certain conditions and to compare the WTA with the number of ecopoints that could be generated by this measure and the resulting price per ecopoint using the example of the ÖKVO Baden-Württemberg. To our knowledge, there are just a few studies dealing with farmers' preferences for nature conservation measures or biodiversity offsets on farmland, for instance Vaissière et al. (2018), who specifically looked at the agglomeration of measures at farm level, or Le Coent et al. (2017), who compared farmers' preferences between biodiversity offsets and agri-environmental measures. In contrast, our study focuses on the comparison of different types of measures, especially extensification of arable farming and, above all, on the legal protection of measures. Finally, we aim to make practical recommendations for action for policy makers to improve the factoring in of agricultural interests in terms of nature conservation compensation and to help to defuse land use conflicts between agriculture and nature conservation. We therefore suggest how voluntary compensation measures by farmers could be used to achieve greater benefits for nature conservation than has been the case to date.

2. Material and methods

2.1. Basics of the discrete choice experiment

Individuals have preferences for specific alternatives that can be observed through their choice of one alternative (Hensher et al., 2015). According to Lancaster (1966), the utility of a good for the consumer depends on its specific characteristics. It can be assumed that individuals choose a good or an alternative that maximizes their utility. The purpose of stated choice experiments, such as discrete choice experiments (DCEs), is to determine the independent influence of these characteristics or attributes that are related with one good or alternatives to choose from (ChoiceMetrics, 2018). This method fits our objectives. A description is, therefore, given of the basics of DCEs.

In general, the utility of an alternative j that is recognized by an individual n in a choice situation d can be divided into the specified model part V_{ndj} and into a stochastic and thus unexplainable, residual component ε_{ndj}. This can be written as follows (Hensher et al., 2015):

$$U_{ndj} = V_{ndj} + \varepsilon_{ndj} \tag{1}$$

In addition, it is usually assumed that the unobservable part V_{ndj} involves a linear relationship between the individual levels x_{ndjk} and x_{ndjp} of the non-price attributes k and the price attribute p for respondent n and alternative j in the choice situation d. The coefficients β_{nk} and β_{np} represent the marginal utilities related to the non-price attributes k and the price attribute p for a respondent n with a positive scale factor σ_n, respectively. The utility U_{ndj} can then be formalised as follows (Hensher et al., 2015):

$$U_{ndj} = \sigma_n \sum_{k=1}^{k} \beta_{nk} x_{ndjk} + \sigma_n \beta_{np} x_{ndjp} + \varepsilon_{ndj} \tag{2}$$

In the multinomial logit model (MNL) the probability P_{ind} that an individual will chose alternative i in a choice situation d from a set of alternatives j can be formalised as follows with β describing a combined vector of all parameters present in the model. If a specific alternative j is present in the choice situation d, given to an individual person n, then z_{ind} has a value of 1. Otherwise it has a value of 0. The choice probability $P_{ind}(\beta)$ is furthermore based on the assumption that the residual error term ε_{ndj} is independently and identically distributed (i.i.d.) according to a type I extreme value distribution (Hess and Palma, 2020), and it is given by:

$$P_{ind}(\beta) = \frac{z_{ind} \times exp^{V_{ndi}}}{\sum_{j=1}^{j} z_{jnd} \times exp^{V_{ndj}}} \tag{3}$$

V_{ndj} again stands for the specified model part of the utility function (1) excluding the residual error part (Hess and Palma, 2019a). In the case of a panel structure of the dataset, i.e. when there are multiple observations per individual, the probabilities of the chosen alternative P_{j^*nd} (3) in a choice situation d have to be multiplied across all observations from the same individual T_n, because they are repeated measures. Taking this into account and assuming a given parameter β, the contribution to the likelihood function by an individual n is given by (Hess and Palma, 2020):

$$L_n(\beta) = \prod_{d=1}^{T_n} P_{j^* nd} \tag{4}$$

Now assuming that taste heterogeneity exists between the individuals, random effects can be introduced in the model as an extension of the MNL (McFadden and Train, 2000). For the decision to take a factor as fixed or random it should be considered whether the factor levels can be regarded as a random sample of the population, for instance blocks in the study design represent a random selection of all blocks that could be generated. When comparisons are to be made among the levels of a factor, then it should be taken as fixed effect. In the mixed logit model with multiple observations per individual and the assumption that the preferences of the individuals are constant across choice situations, the likelihood for the choices of person n can be formalised as follows (Hess and Palma, 2020):

$$P_n(\Omega) = \int_\beta \prod_{d=1}^{T_n} P_{nd}(j^* nd \mid \beta)\, g(\beta \mid \Omega)\, d\beta \tag{5}$$

The coefficients β cannot be observed by the researcher, but instead it is assumed that there is variation in the population with the density $g(\beta|\Omega)$, where Ω is a vector with the parameters of the distribution such as the mean and variance that characterise the distribution (Hess and Palma, 2019a; Train, 2000). In our study we assume that the random effects are normally distributed.

The mean and variance of $g(\beta|\Omega)$ are now estimated by a numerical simulation taking a number of draws from the density g and calculating the choice probability. The procedure leads to a simulated choice probability as the average of these calculations (Train, 2000). One method for creating these draws is to use Halton sequences (Halton, 1960).

One goal of the DCE approach in economic studies is to obtain measures for willingness to pay (WTP) or willingness to accept (WTA). The marginal WTA (MWTA) is calculated ceteris paribus by the ratio of the parameter estimates of the non-price attributes β_k and the cost coefficient β_p (6). To obtain informative and interpretable estimates for the MWTA, the monetary coefficient can be fixed (e.g. (Narjes and Lippert, 2016; Revelt and Train, 1998)), i.e. the distribution will take the same form as the distribution of the attribute. Otherwise, the estimation of the MWTA will be quite complex, as described, for instance, by Ruud (1996). The mean and variance of the MWTA can thus be scaled by dividing by the fixed monetary coefficient (Scarpa et al., 2008):

$$MWTA_k = \frac{\beta_k}{\beta_p} \tag{6}$$

In the agricultural sector, DCEs are widely used to measure farmers' preferences for biodiversity conservation and the design of agri-environmental programs (Espinosa et al., 2010; Greiner, 2016; Schulz et al., 2014; Vaissière et al., 2018). Hence, a discrete choice experiment (DCE) was conducted to analyse farmers' preferences for compensation measures on arable land and to analyse the influence of the different attributes on farmers' decisions.

2.2. Experimental design

The respondents had to choose between a status quo scenario, i.e. not conducting any compensation measure, and two other hypothetical scenarios involving the implementation of a certain kind of compensation measure. Each alternative is described using several attributes and always refers to 1 hectare of arable land. Since arable land usually has a much lower value than grassland for nature conservation purposes – for instance four ecopoints per m^2 whereas extensive grassland has 13 ecopoints per m^2 according to the ÖKVO in Baden-Württemberg – there is a corresponding high potential for upgrade. Therefore, the study took into account three typical types of compensation measures on arable land (Wende et al., 2018), i.e. PIC as an extensification of the land use, conversion into grassland, and complete transfer to nature conservation on land owned by the farmer, combined with other attributes, as given in Table 1. Each alternative described by these attributes refers to 1 hectare of arable land.

The attributes and attribute levels were defined on the basis of the results of 10 previous extensive interviews (1–2 h) with farmers in the Stuttgart Region and discussions with institutions involved in the compensation process, i.e. Flächenagentur Baden-Württemberg, Ökoagentur Bayern and Stiftung Kulturlandschaft Rheinland-Pfalz. The goal was to address the formulated hypotheses as precisely as possible. Therefore, especially the entry in the land register in connection with a possible loss of value of the land as well as the commitment period were defined directly as attributes. In addition, socio-demographic characteristics of the participants and characteristics of their farms were surveyed. In order to address the type and design of measures, the concrete type of measure and administrative handling were also included as attributes, and of course the amount of compensation paid.

The decision to carry out a compensation measure on a land parcel might result in a certain market value loss of the agricultural land. The actual loss is unknown unless the land is sold. Nevertheless, there is probably an expectation regarding the maximum market value loss, which is oriented towards the standard land values (BRW) published by expert committees on the municipality level. Therefore, the farmers were given the levels 1 €, 5 € and 9 € per m^2.

In addition, we paid special attention to the effect of the land register entry on the acceptance of compensation measures. The land register entry is valid in perpetuity, which means that the compensation measure will be implemented permanently, too. In the previous interviews the duration of the maintenance period likewise seemed to have an impact. This attribute was therefore included with the levels 5 years, 15 years and 25 years. A combination with a land register entry would mean that, for instance, the farmer would be responsible for keeping the compensation measure in a certain condition for a duration of 25 years. However, after 25 years, it still would not be possible to convert the compensation area back into arable land, but the cost for maintenance of this (former) agricultural land is probably much lower. Even if there were no longer an obligation under the IMR to care for the measure, there are still other laws to observe, like the law of agriculture and landscape management of Baden-Württemberg (LLG). According to the LLG, farmers are forced to comply with the obligations resulting from

Table 1
Attributes and corresponding levels for the choice alternatives.

Compensation measure attribute	Levels	Type of variable
Possible maximum market value loss of the farmland	0 €/m^2[b], 1 €/m^2, 5 €/m^2, 9 €/m^2	Metric
Land register entry	• Yes • No[a]	Categorical
Duration of the maintenance period	0 years[b], 5 years, 15 years, 25 years	Metric
Type of compensation measure	• PIC (30% yield loss) • Grassland: conversion of farmland into extensive grassland (50% less yield than intensive grassland), • Nature conservation (100% yield loss) • No measure[b]	Categorical
Rotation	• Yes • No[a]	Categorical
Completing regulatory requirements	• Yes • No[a]	Categorical
Annual payment per hectare	0 €[b], 1000 €, 2000 €, 3000 €, 4000 €	Metric

[a] Attributes were fixed at this level for the no-choice (status quo) alternative.
[b] These levels of the attributes are fixed for the no-choice (status quo) alternative and do not appear in any other alternatives.

the rules of maintenance obligations for agricultural land, for instance proper grazing or at least one mowing per year for grassland. The main difference between a measure with land register entry and absence thereof is therefore the finiteness. Without the land register entry, the agricultural land could be used again for farming after the given duration of the maintenance period or even for other purposes. This is likely to be more difficult when there is a land register entry. It can be assumed that the market value will be very much influenced by the land register entry, but even without a land register entry the land cannot be used for other purposes for a long time, for instance 25 years. We ruled out the combination of a land register entry and a maintenance period of 5 years for the same property, as this is not plausible.

As mentioned above, we included three different but typical types of compensation measures in the study. In this study, extensification of farming is actually related to PIC. It means that the farmer will keep his current crop rotation, however, with a yield loss of 30%. As there are many kinds of PIC-measures and they can be very flexible and individual in practice, we did not specify how the extensification would actually be implemented as this would lead to an overly large number of measures for the DCE method. Nevertheless, a common feature of nearly all kinds of PIC is that they will result in certain yield losses. Therefore, it is important that the land can be further used for cropping, but in an extensive way. The second type of compensation measure is the conversion of arable land into grassland with rather extensive use. We therefore defined a yield loss of around 50% in comparison to intensively used grassland at the site of the farmer, which seemed to be realistic according to Neubert and Fechner (2001). The third measure is the complete transfer of the arable land for nature conservation, i.e. a yield loss of 100%. However, we explicitly pointed out that this does not include the planting of trees etc. as it should be possible to use the land again for farming after the maintenance period. Nevertheless, we made a restriction that the complete transfer for nature conservation in combination with a maintenance period of 25 years is always linked to a land register entry as this seems more realistic in order to generate a certain habitat structure or biotope type that has a high value for nature conservation.

Some measures like PIC could also be integrated into the crop rotation, for instance flower strips. This would mean that the compensation measure alternates annually between parcels. This is not possible, however, for the conversion of arable land into grassland. In combination with a land register entry this means that one parcel serves as the so-called "anchor site" for the compensation measure. The market value loss will then be related to the anchor site.

The establishment of an eco-account or compensation measure generally involves a certain administrative effort and certain regulatory requirements have to be completed with the nature conservation authorities. This might be quite complex and time consuming. In the DCE we therefore included the attribute "Completing regulatory requirements", which means that the farmer is responsible for the legal processing of the compensation measure or this is all done by a third party, for instance a commercial compensation agency. We did not include a price for this service, but the farmers will probably anticipate certain costs for this service. Lastly, the annual payment per hectare is included in the attribute set. For the duration of the maintenance period the farmers will receive the given payment per hectare annually. After this period there will be no further payment. If the farmer generates ecopoints, these are usually sold once and then there will be no further payment by the intervener. Because of the variety of measures and duration, no one-off payments could be included. Furthermore, we stated that this is a net amount from an income tax point of view.

In total, there were 864 possible combinations of the attribute levels. They included design constraints to eliminate unrealistic choice tasks, and 552 combinations remained. In total, 100 combinations, i.e. 50 choice situations were used and put into 10 blocks, each consisting of 5 choice situations. Thus, the participants had to make 5 decisions. According to the formula $S = K/(J-1)$ with S as the minimum number of choice situations required, the number of parameters to be estimated K and the number of alternatives per choice situation J (ChoiceMetrics, 2018), this is a sufficient number of choice situations to estimate 100 parameters. This was a sufficient number for the study. A Bayesian efficient augmented design was generated using the software Ngene (ChoiceMetrics, 2018).

To generate an augmented design, a beta version of Ngene including this new feature was provided by ChoiceMetrics (Andrew Collins, 2019). The Bayesian design depends on prior information on the values of the parameters β in the model, i.e. prior parameter values $\tilde{\beta}$. For the generation of the design only the main effects of the attributes were considered. No other effects were taken into account. Since no information was available on the parameters of these effects at the beginning, the D_z-error (7) was used as an efficiency measure for the initial design. It is based on the determinant of the asymptotic variance-covariance (AVC) matrix Ω_1 of the experimental design X, the parameter values $\tilde{\beta}$, which were set to zero in this case, and the number of parameters K (ChoiceMetrics, 2018). The initial design was generated after 116,175 evaluations with a D_z-error of 3.37E-4 as D_z-optimal design, optimized for a MNL-model. After 105 participants completed the survey, we undertook an initial analysis of the dataset and were able to obtain a priori estimates for the mean and standard deviation of the main effects of the attributes in the model. We thus generated 10 new blocks to replace the existing blocks in the survey, now in terms of the D_b-error (8) as the efficiency measure. The a priori parameters $\tilde{\beta}$ were assumed to be random and to follow a normal probability density function $f()$ with parameters θ. Thus, $\tilde{\beta}$ was assumed to be drawn from this distribution with given parameters θ, i.e. the mean and variance of the prior distribution as estimated from the first analysis (ChoiceMetrics, 2018). By using the augmented design feature, a D_b-optimal Bayesian design was generated after 37,089 evaluations with a D_b-error of 1.12E-04. which takes the uncertainty of the estimates into account (ChoiceMetrics, 2018). One choice set is presented below by way of example (Fig. 2).

$$D_z - error = \det[\Omega_1(X, \tilde{\beta})]^{1/K} \text{with } \tilde{\beta} = 0 \tag{7}$$

$$D_b - error = \int_{\tilde{\beta}} \det[\Omega_1(X, \tilde{\beta})]^{1/K} f(\tilde{\beta} \mid \theta)\, d\tilde{\beta} \tag{8}$$

At the beginning the respondents were requested to answer questions on their farm structure, for instance farm size and socio-demographic characteristics. Then the respondents were introduced to the IMR in Germany and given the hypothetical scenario, indicating that they now have an opportunity to carry out the nature conservation compensation measure to offset the impact of the building of a new railway line. The respondents were told that, after consultation with the nature conservation authorities, two areas of their farm were eligible for compensation measures. These are in the respondents' ownership and differ among other things in terms of standard land value (BRW). As a result, the compensation measure may lead to different losses in market value. In addition, it may be necessary to register the measure in the land register. In the next step the attributes and levels in the DCE were explained in text and symbols, which were designed to make the DCE more manageable for the respondents. Next, they were randomly assigned to one of the 10 blocks of choice sets.

2.3. Sampling of participants

The DCE was conducted between September 2019 and March 2020 online and offline. For the acquisition of respondents, we published articles in several regional weekly agricultural magazines across Germany, for instance Bayerisches Landwirtschaftliches Wochenblatt. The articles informed the farmers about the legal framework of the IMR and drew attention to our study, a description of which was provided via an online-link. Furthermore, we used the information channels of farmers' organisations, for instance the farmerś and vintnerś association of

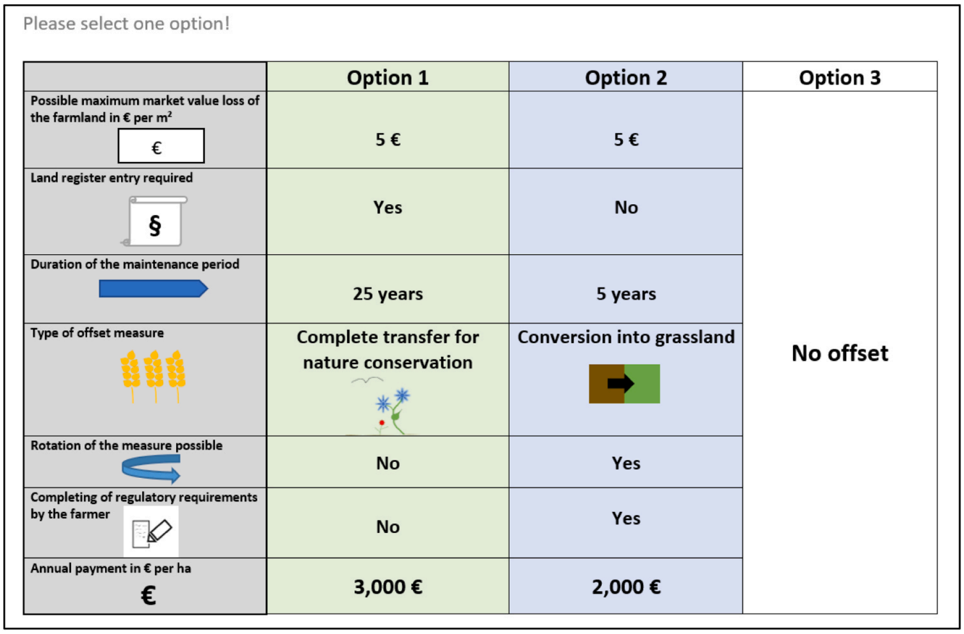

Fig. 2. Example of a choice situation.

southern Rhineland-Palatinate (Bauern- und Winzerverband Rheinland-Pfalz Süd e.V.), to reach a large number of potential respondents for participation online. In the online survey each respondent was given one block, i.e. five choice situations.

In addition, we also held events on-site at three locations in the Stuttgart Region in cooperation with the local farmers' organisations (Fig. 3).

In contrast to the online survey, each participant was assigned to two blocks of choice situations during the event. Analogous to the online survey, the participants were introduced to the topic, the hypothetical initial situation and the attributes in the DCE by an oral presentation and slides. Then they responded to the first set of choice situations, which were distributed in sealed envelopes. After completing their responses, we asked them to put the questionnaire back in the envelope. We then continued the oral presentation about the IMR in Germany. The next part of the presentation included some additional information on the alternative possibilities of the legal protection of a compensation measure and the potential uses and obligations to care for the compensation

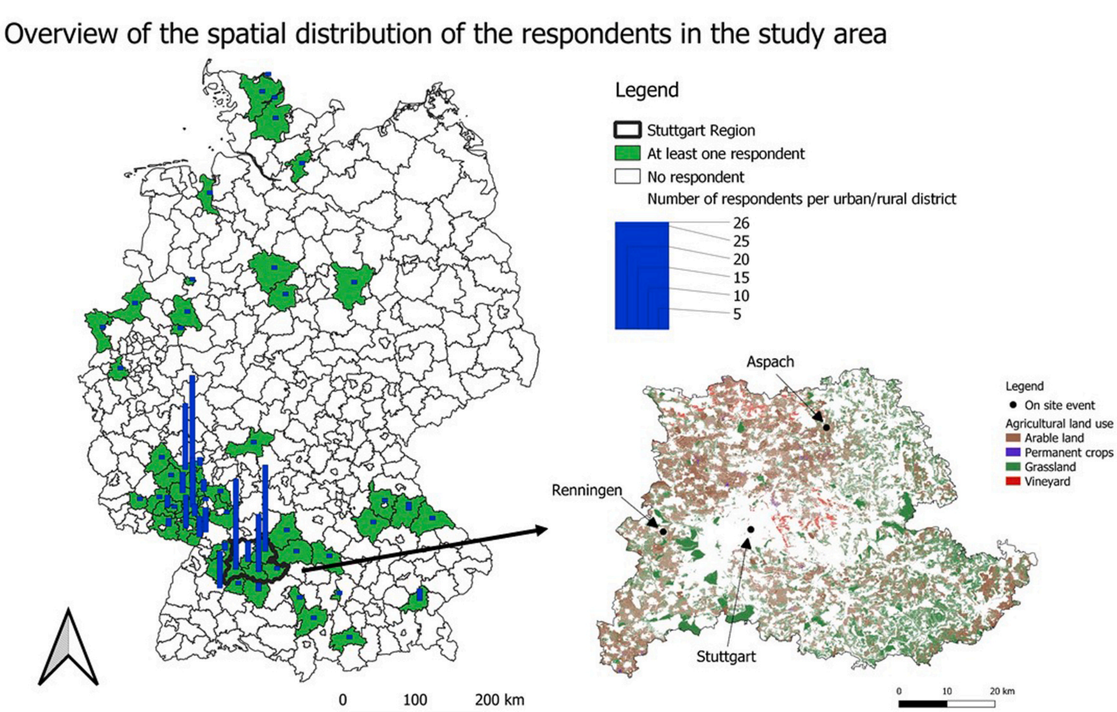

Fig. 3. Overview of the spatial distribution of the respondents in the study area and of the agricultural land use (based on data from the integrated administration and controlling system (InVeKoS) provided by the Ministry of Rural Affairs and Consumer Protection Baden-Württemberg) in the Stuttgart Region including the locations of the on-site events (BKG, 2018).

measure, even after the expiry of the maintenance period under other laws. This included the information that the land register entry might be for a site other than the compensation site, for instance on land owned by the intervener. In addition, we informed them that although the reconversion of grassland into arable land is possible by law, there might be some restrictions in individual cases even without a land register entry. It rather depends on the decisions of the authorities in individual cases, because grassland is also protected by other laws, for instance the LLG in Baden-Württemberg. We also told the participants about the care and management obligation of agricultural land outside the BNatSchG.

In total, 209 farmers from nine federal states completed the DCE. There were 133 respondents in the online survey and 76 during the three on-site events, of whom 75 also completed the second set of choice situations. All in all, this resulted in 1420 observations. Table 2 gives some descriptive statistics of the sampled population and farm characteristics. An overview of the spatial distribution of the respondents in the study area is given in Fig. 3.

2.4. Data analysis

The dataset was analysed using the 'apollo' package (Hess and Palma, 2019b) in R (R Core Team, 2019), accounting for the panel data nature. Firstly, we fitted a MNL model including just the main effects of the seven attributes in a choice set as the base model. In order to explain parts of the heterogeneity in means of the parameter estimates, we conducted a structured model selection process. Due to the very high number of potential covariates and interactions, a stepwise selection would be very costly in terms of time and computing power. Therefore, a pre-selection was made by testing the influence of all potential covariates individually. Potential covariates were the descriptive and socio-demographic variables presented in Table 2, i.e. the main effects and two-way interactions with the attributes in the DCE as well as the two-way interactions between all attributes. For this purpose the extended models were compared individually with the base model using the Akaike information criterion (AIC) (Akaike, 1974). As the AIC might be quite liberal (Kass and Raftery, 1995), variables were selected based on a delta AIC of at least 10. According to Burnham and Anderson (2004), a model M_1 fitted to the same data set as model M_2 and improving the AIC by 10, has fundamental support. During the selection process, 186 potential covariates and interactions were tested, of which at least 13 led to an improvement of more than 10 in the AIC value of the model. On the basis of these selected variables, we adopted a stepwise selection approach. Finally, six covariates or interaction terms were selected to be included in the final model. In comparison to the base with an AIC value of 2679.82, the AIC could be improved by −97.84. This is because he compensation measures PIC and complete transfer to nature conservation were actually included as dummy variables, i.e. keeping the category 'no measure' as the reference fixed at zero (alternative specific constant of the status quo). We then created a numeric variable of the yield loss to combine these two levels and removed the two corresponding dummy variables. This means that PIC was coded with a 30% yield loss and the transfer for nature conservation and conversion to grassland were each coded with a 100% yield loss in relation to arable production. Grassland was kept as a dummy variable, indicating the conversion by 1 and setting it to 0 otherwise. Although this allowed us to obtain a greater amount of information, the AIC of the model could still be improved by −1.57. The two dummy variables were also partly substituted in the selected covariates, based on AIC. In most cases it turned out to be advantageous to leave the dummy variables in the interaction terms. Finally, we added random effects for the blocks of choice situations and the federal state to account for the spatial heterogeneity of the origin of the respondents using 150 Halton draws (Train, 2000). Using the symbolic notation for mixed models in Piepho et al. (2003), the final model can be stated as shown below (9). Fixed and random effects are separated by a colon, effects are added by the "+" operator, crossed effects are defined using the "·" operator to concatenate the factors involved, nested effects are stated using a "/" to represent nesting relations between factors, and the residual error is underlined.

$$\begin{aligned}&Market\ \ value\ loss + land\ register\ entry + Maintenance\ period + Yield\ loss\\&\quad + Grassland + Rotation + Regulation + Payment + Farm\ successor\\&\quad + Organic{\cdot}PIC + Yield\ loss{\cdot}land\ register\ entry\\&\quad + Stuttgart\ Region{\cdot}Nature\ conservation + Online{\cdot}land\ register\ entry\\&\quad + Additional\ information\\&\quad :\ Block + Federal\ state + \underline{Error}\end{aligned} \tag{9}$$

All attributes in the DCE, i.e. the possible maximum market value loss of the farmland (*Market value loss*), land register entry (*Land register entry*), the duration of the maintenance period (*Maintenance period*), the yield loss caused by the compensation measure (*Yield loss*), the conversion of arable land into grassland (*Grassland*), the possibility of the rotation of the measure (*Rotation*), the completing regulatory requirements (*Regulation*) and the annual payment per hectare (*Payment*) were included. In addition, the covariate *Organic·PIC*, indicating interaction between organic farms and PIC, was selected. Furthermore the interaction *Yield loss·land register entry*, i.e. the effect of the land register entry depends on the yield loss caused by the measure, was selected. The interaction *Stuttgart Region·Nature conservation*, implying that the compensation measure nature conservation with 100% yield loss has a different parameter estimate among farmers in the Stuttgart Region than elsewhere, is included in the final model as well. Also the interaction *Online·land register entry* was selected which means that farmers responded differently to the land register entry in the online survey. The dummy variable *Farm successor* indicates that the farm has a successor and *Additional information* takes into account the effect of the second survey during the offline and on-site events after the provision of additional information in the oral presentation. The random effects *Block* and *Federal state* account for the effects of the blocks of choice sets and the federal state where the respondents have their farm. Hence, a variance component and state-specific regression coefficients were estimated for the federal states with more than one respondent. The effect *Block*,

Table 2
Selection of descriptive statistics of the sampled population.

Variable	Number	Mean	SD
Form of acquisition of farming			
– Full time	139		
– Part time	70		
Farming system			
– Conventional	179		
– Organic	30		
Total farmland (ha)		68.49	73.99
Arable land (ha)		48.73	66.00
Grassland (ha)		13.60	22.05
Share of arable land (%)		55.63	35.87
Share of speciality crops (%)		24.18	36.81
Share of leased land (%)		46.59	27.77
Age			
– < 30	20		
– 30 – 39	44		
– 40- 49	36		
– 50 – 59	64		
– > 60	45		
Female	14		
Male	195		
Successor of the farm			
– Yes	69		
– No or uncertain	140		
Total number of participants	209		
Number of choice observations	1420		

following a normal distribution with zero mean, is integrated as a variance component parameter. Finally, the residual error *Error* can be interpreted as the effect of each individual decision by one person. In order to obtain economically robust estimates for the MWTA, the payment attribute was held fixed in the process of model fitting (Hensher et al., 2015; Scarpa et al., 2008). Without the fixation, the payment attribute proved to be significant. In a second step, the coefficient estimates that were not different from zero at a significance level of 5% were fixed at zero to obtain the MWTA for the significant attributes. The McFadden pseudo R^2 indicates a good model fit (Hensher et al., 2015). Moreover, taking into account the coefficient estimates of the non-random parameters that proved to be significant at a significance level of 5%, 55.70% of the observed choices can be predicted accurately. However, the decisions of the farmers in Stuttgart Region can be predicted correctly with a probability of 64.88%.

2.5. The relationship between marginal willingness to accept and nature conservation upgrading

The MWTA for the three types of compensation measures are now placed in relation to the possible nature conservation upgrading using the example of the assessment scheme in the ÖKVO in Baden-Württemberg in ecopoints. The goal is to estimate the supply price for these three measures per ecopoint. Since compensation measures like PIC are not mentioned in the ÖKVO, the type of biotope created by the measure must be assessed by the lower nature conservation authorities in each individual case. We have therefore based our valuation on practical cases (Beck, 2019; Dreher, 2016).

PIC could be established by means of annual strips of field flowers and native wild flowers on 30% of the parcel, for example. In practice this can be awarded 12 ecopoints per m^2. As the initial value of arable land is 4 ecopoints per m^2 it means an improvement of 8 ecopoints per m^2 on the area covered by the flower strips. In the case of a total parcel area of one hectare, this means an improvement of 24,000 ecopoints per hectare. The conversion of arable land into grassland with extensive use, i.e. one cut per year, can be awarded 13 ecopoints in the target condition. Hence an improvement of 90,000 ecopoints per hectare can be achieved. The complete transfer to nature conservation, for instance perennial wildflower strips or flowering meadows, is in practice often awarded 19 or 21 ecopoints depending on the target biotope type. In our study we assume a target condition of 16 ecopoints per m^2, i.e. an improvement of 120,000 ecopoints per hectare (Table 3).

3. Results

The farmers decided in 49.01% of the observations to carry out one of the offered compensation measures. In the final model with covariates

Table 3
Summary of the compensation measures considered and their evaluation in ecopoints.

Compensation measure	Evaluation of the initial condition of the area in ecopoints per m^2	Evaluation of the target condition of the area in ecopoints per m^2	Improvement per ha arable land in ecopoints
PIC (30% of the area)	4	12	24,000
Conversion to Grassland	4	13	90,000
Nature conservation (100% of the area)	4	16	120,000

and fixed payment attribute, the potential market value loss, the land register entry, the duration of the maintenance period, the loss of yield, conversion to grassland and rotation were significant (Table 4). The payment attribute was also highly significant before fixing, i.e. it can be used to obtain estimates for the MWTA. In addition, all covariates identified in the process of variable selection were significant. We were unable to prove any significant impact of the duration of the maintenance period or the type of legal processing. The effect of the land register entry declines with the amount of potential yield loss, for instance it has a smaller impact in the case of a complete transfer of the land to nature conservation with 100% yield loss. If farmers have a successor for their farm, their acceptance of compensation measures is in general considerably lower. Organic farms in particular have a lower acceptance of PIC. Moreover, it was shown that the survey medium has an influence according to the land register entry. In the online survey farmers were more willing to accept the land register entry in general. Finally, we could also prove that the additional information provided during the offline on-site events had an influence on the farmers' decisions. Once they knew more about the legal framework and potential additional obligations arising from other laws concerning compensation measures, they were less willing to opt for a compensation measure.

Using the estimates for the MWTA presented in Table 4, the WTA for different scenarios was calculated (Table 5). Using the standard land values (BRW) as an approximate value for the maximum market value loss, we differentiated between two scenarios where a land register entry is either required or not. Furthermore, there is a need to differentiate between farmers who have a farm successor and those who do not. In order to take the effect of the information and survey medium into account, 50% of the parameter estimates for these attributes are used in both cases, i.e. 0.29605 and 0.298, for further calculations. This can be justified by the fact that the level of knowledge of the online participants about the legal framework was not known and both estimates were derived from approximately 50% of the total observations. It might also be the case that the individuals participating offline would have decided otherwise if they had participated online. This means that the real WTA is probably between the WTA derived online and offline or between both levels of the dummy variable regarding the additional information. If no land register entry is required, the PIC is accepted at a much lower price than the other measures. The conversion of arable land into grassland is the least well-accepted measure, i.e. the highest payment is expected by the farmers. Nevertheless, the difference between nature conservation and conversion into grassland is quite small. Assuming that a land register entry is required, PIC still requires the smallest payment. However, the relative excellence over the other measures is less than without an entry.

Assuming that a land register entry is required, which is usually the case for a non-rotating compensation measure, we estimated the required price per ecopoint based on the WTA of the scenario with land register entry in Table 5. We, therefore, assumed that the farmers receive the annual payment or the WTA given in Table 5 for a duration of 25 years. To determine the price per ecopoint (Table 6), the annual payments were capitalised based on an interest rate of 2%, which means a one-off payment to the farmer at the beginning of the measure. The calculated capital value was then divided by the number of ecopoints generated by the different measures (Table 3).

If the BRW and loss of yield are set to zero in the calculation of the values in Table 5, then farmers without a farm successor would expect 48,771.0 €/ha for the implementation of PIC, 51,059.9 €/ha for the conversion of arable land into grassland and 32,844.6 €/ha for the complete transfer to nature conservation and 46,731.7 €/ha in the Stuttgart Region respectively. The loss of yield must of course also be compensated and, in the case of PIC or nature conservation, additional costs as well, for instance seeds for flower strips, as these costs are included in the loss of yield parameter.

The price per ecopoint which determines farmers' acceptance of the compensation measure varies between the measures. Even if PIC is in

Table 4
Coefficients of the MMNL model with fixed payment attribute and the MMNL model with fixed payment and fixed nonsignificant attributes and MWTA estimates (all € are in values of 2020).

Variable	Final Model		Model for MWTA		
	Coefficient[a]	(SE)	Coefficient[a]	(SE)	MWTA (€/ha/year)
Market value loss	−0.0579**	(0.0182)	−0.0672***	(0.0177)	−96.0
Land register entry	−1.9697***	(0.2959)	−2.1027***	(0.2841)	−3003.9
Maintenance period	−0.0111	(0.0069)	Fixed at zero		
Yield loss	−0.0111***	(0.0025)	−0.0117***	(0.0022)	−16.7
Grassland	−0.5253**	(0.1723)	−0.5445**	(0.1677)	−777.9.
Rotation	0.2287*	(0.1100)	0.2210*	(0.1084)	315.7
Regulation	0.1339	(0.0914)	Fixed at zero		
Payment	0.0007	Fixed parameter	0.0007	Fixed parameter	
Farm successor (yes)	−0.9130*	(0.4489)	−1.2736**	(0.3744)	−1819.4
Organic·PIC	_1.5388***	(0.2991)	−1.5833***	(0.2938)	−2261.9
Yield loss·Land register entry	0.0084*	(0.0039)	0.0090*	(0.0037)	12.9
Stuttgart Region·Nature conservation	−0.5103*	(0.2206)	−0.4656*	(0.2154)	−665.1
Online(yes)·Land register entry	0.6128**	(0.2146)	0.5960**	(0.2124)	851.4
Additional information	−0.5293*	(0.2110)	−0.5921**	(0.2073)	−845.9
Block (SD[c])	−2.1626***	(0.3960)	−2.2457***	(0.5145)	−3208.1
Federal state (BW[1])	−0.5131	(0.4620)	Fixed at zero		
Federal state (RP[1])	−0.6476	(0.3886)	Fixed at zero		
Federal state (BAY[1])	0.7656	(0.8903)	Fixed at zero		
Federal state (HE[1])	3.1591	(2.5192)	Fixed at zero		
Federal state (NRW[1])	0.9595	(1.3212)	Fixed at zero		
Federal state (LS[1])	−0.5575	(1.4735)	Fixed at zero		
Federal state (SH[1])	0.7732	(1.5252)	Fixed at zero		
Federal state (SD[c])	1.4480**	(0.5580)	1.5299*	(0.7241)	2185.6
Log-Likelihood (LL)	−1059.251		−1066.839		
AIC	2162.5		2159.68		
McFadden pseudo R^2	0.2777[b]		0.2725[b]		

[a] Significance levels: *p < 0.05, **p < 0.01, ***p < 0.001.
[b] The calculation was done in relation to the Log-Likelihood function of a restricted model that contained two constants set on each of the two compensation options only.
[c] Standard deviation.
[1] Abbreviations of the federal states: BW: Baden-Württemberg, RP: Rhineland-Palatine, BAY: Bavaria, HE: Hesse, NRW: North Rhine-Westphalia, LS: Lower Saxony, SH: Schleswig-Holstein

general more accepted by farmers, the improvement in ecopoints per hectare is somewhat smaller than for the other measures. Thus, a potential intervener would have to pay more for PIC than for other measures. From an economic point of view the complete transfer to nature conservation results in the lowest costs per ecopoint, even if about 0.11 € more have to be paid per ecopoints in the Stuttgart Region than in the rest of the study area for this kind of measure.

4. Discussion

From the results of the DCE, we were able to confirm our hypothesis that farmers are in general willing to conduct compensation measures voluntarily, even in urban areas like the Stuttgart Region. The type of measure and the monetary compensation are therefore highly relevant (H1). However, the standard errors of the parameters also show that farmers are not a homogeneous group and some may also reject compensation measures as a matter of principle. However, this could not

Table 5
WTA in € per hectare per year for BRW[a] and different non-rotating compensation measures under different conditions of land register entry as well as the as the distinction between whether there is a farm successor or not (all € are in values of 2020).

Additional conditions	No land register entry [€/ha/year]				With land register entry [€/ha/year]			
	PIC	Grassland	Nature conservation		PIC	Grassland	Nature conservation	
			Sample mean	Stuttgart region			Sample mean	Stuttgart region
No farm successor								
BRW: 1 €	1020.4	2968.2	2190.4	2855.5	3212.8	4260.6	3482.8	4147.9
BRW: 5 €	1404.4	3352.2	2574.4	3239.5	3596.8	4644.6	3866.8	4531.9
BRW: 9 €	1788.4	3736.2	2958.4	3623.5	3980.8	5028.6	4250.8	4915.9
Farm successor (yes)								
BRW: 1 €	2839.8	4787.6	4009.8	4674.9	5032.2	6080.1	5302.2	5967.4
BRW: 5 €	3223.8	5171.6	4393.8	5058.9	5416.2	6464.1	5686.2	6351.4
BRW: 9 €	3607.8	5555.6	4777.8	5442.9	5800.2	6848.1	6070.2	6735.4

[a] Standard land value.

Table 6
Calculated capital values in € per hectare over a period of 25 years and required prices for different non-rotating compensation measures using a discount rate of 2% (all € are in values of 2020).

Condition	PIC		Grassland		Nature conservation			
					Sample mean		Stuttgart region	
	Capital value [€/ha]	Price per ecopoint [€]	Capital value [€/ha]	Price per ecopoint [€]	Capital value [€/ha]	Price per ecopoint [€]	Capital value [€/ha]	Price per ecopoint [€]
• No farm successor								
BRW: 1 €	62,723	2.61	83,180	0.92	67,995	0.57	80,979	0.67
BRW: 5 €	70,220	2.93	90,677	1.01	75,492	0.63	88,476	0.74
BRW: 9 €	77,717	3.24	98,173	1.09	82,988	0.69	95,973	0.80
• Farm successor (yes)								
BRW: 1 €	98,244	4.09	118,702	1.32	103,515	0.86	116,502	0.97
BRW: 5 €	105,740	4.41	126,199	1.40	111,012	0.93	123,998	1.03
BRW: 9 €	113,237	4.72	133,695	1.49	118,509	0.99	131,495	1.10

be explained by other socio-demographic characteristics of the participants. Nevertheless, this also corroborates the results of other studies on agri-environmental measures, according to which the self-identity of farmers in particular has a major influence on the acceptance of such measures (Home et al., 2014; Karali et al., 2014; van Dijck et al., 2016). In accordance with the design of the measures, we also found that the possibility to implement the measure in rotation was significant. In contrast to PIC and the complete transfer of farmland to nature conservation, the conversion of arable land into grassland seems to be the least accepted measure, at least in farms and regions with fewer ruminants such as cattle. PIC still allows cropping on the area and can be established by most of the farms with their existing equipment. This is also true for the complete transfer to nature conservation which probably requires the least amount of maintenance during the year. The conversion of grassland is not easy to implement for all farms, as the machinery is not available and there is no possibility of use, especially for arable farms. In addition, the feeding value of the grassland might be quite low due to extensive use with a probably late cutting date. Therefore, it is not even attractive for farms with livestock, which might explain why we could not identify any significant interactions between the share of grassland as an indicator for the keeping of livestock of the farms and the type of compensation measure. The influence of farm size or the percentage of high value-added special crops like vegetables etc. in the crop rotation could not be proved (H2). Thus, we are not able to accept this hypothesis. One possible reason could be that the loss in value of the land can significantly exceed the yield value.

In addition, the effect of the duration of the maintenance (p value: 0.121) was not significant (H4). Nevertheless, one should not completely neglect this effect. For agri-environmental measures in the second pillar of the CAP, the contract term is usually five years. As there are certain parallels between compensation measures and agri-environmental measures, especially for PIC (Druckenbrod and Beckmann, 2018), compensation measures with a short contract term would be in strong competition with these measures. In any case, the maximum term in the DCE was 25 years which seems to be an acceptable term, even from a legal perspective (Louis, 2010; Lütkes and Ewer, 2018). Just for management or maintenance measures such as PIC, a temporal limit is sometimes criticised, because no self-viable target condition of the compensation site can be achieved (BeckOK, 2020; Bunzel, 2004). However, in a DCE with farmers in France, Vaissière et al. (2018) could show that the contract term had a significant negative impact on the acceptance of biodiversity offset contracts. In relation to the maintenance period, the land register entry had a huge effect on the decision in favour of a compensation measure because this would result in the compensation measure indeed being in perpetuity. We could prove our hypothesis that the land register entry reduces farmers' acceptance of compensation measures (H3). Hence, we can confirm the findings by Busse et al. (2019). Also in other countries, for instance the US, mitigation banking approaches require the securing of land in perpetuity by conservation easements, which can also be a major challenge in general (Jenner and Howard, 2015). We could also identify a significant interaction between the land register entry and the amount of yield loss, i.e. a less negative utility for the complete nature transfer than for PIC according to the marginal effect of the land register entry. In the case of PIC, the only logical consequence for the farmer would be to carry on the measure or to allow a proportion of land to lie fallow after 25 years. This could be more costly than leaving the land to succession with a minimum of maintenance.

In general, measures like PIC make high demands on monitoring and might therefore be quite expensive and legally complex (Druckenbrod and Beckmann, 2018; Schrader, 2012). It can be assumed that an alternating compensation measure might be even more complex when it comes to monitoring. On the one hand there might be an opportunity to integrate the measure into crop rotation, for instance just for cereals, and to secure advantages in some cases. On the other hand, this could also cause problems, for instance the carry-over of problematic weeds from parcel to parcel.

We can also accept our hypothesis that there are significant differences between rural and urban areas depending on the acceptance of compensation measures by farmers (H5). The prices and standard land values (BRW) for arable land are usually much higher in urban than in rural areas. Higher monetary compensation is therefore required. The effect of the possible market value loss did not significantly interact with the land register entry. Even without a land register entry, the land cannot be used for any other purpose during the contract term, i.e. opportunity costs can still arise. We could also prove that especially in the Stuttgart Region – an urban area with a high volume of land consumption – farmers are less willing to free up land completely for nature conservation than in other regions (H5). Therefore, this initial hypothesis can be partly accepted. Furthermore, we were able to show that farmers decide differently when they are better informed about the legal framework of compensation measures (H6). In order to neither underestimate nor overestimate the effect on the entire population, we used the mean value of the levels with and without information to calculate the WTA. For this reason, clear uniform and legally certain instructions for action should be provided for (all) farmers as well as for the nature conservation authorities. This enables better planning with lower transaction costs on both sides. In addition, we can also accept our hypothesis that compensation measures are less well received when a farm has a successor (H7). In terms of sustainability, farmers are therefore keen to preserve the land that forms the basis of the farm for future generations. A negative effect of the presence of a farm successor on the acceptance of long-term contracts for agri-environmental schemes was also observed by Ruto and Garrod (2009), for example.

Of the total number of 209 participants, 65 came from the Stuttgart Region. About 50% of them were part-time farmers, which is slightly below the average of about 61% in the Stuttgart Region. Furthermore, most farmers were aged between 40 and 50, which is quite representative for Baden-Württemberg. Small farms with less than 20 ha were rather underrepresented (Statistisches Landesamt Baden-Württemberg, 2017), which was also reported by similar DCEs, for instance Schulz et al. (2014). The DCE is not generally representative for all farms in the Stuttgart Region, but it reflects a relatively high proportion of farms. For Germany, however, the results are not representative as by far not all German federal states were represented. Although our study is therefore in many ways more explorative than representative, we expect our results to be highly informative. The number of participants in some states was only in the single-digit range, however the variance components for the effect of the federal state indicated significant differences between federal states and a significance level of at least 10%. We determined that farmers in the Rhineland-Palatine might have a lower acceptance of compensation measures in relation to the other federal states in the study.

In terms of the land register entry, we found different MWTA measures between respondents participating online and offline. Mjelde et al. (2016) also found that estimates of willingness to pay obtained from an online survey are lower than from a personal interview. They argue that in personal interviews the respondents tend to orient themselves more towards what is expected in society. Therefore, the online survey might be more appropriate, especially for sensitive issues. Furthermore, there are unplanned events and interactions between participants within an offline on-site event. In our experience, compensation measures and land register entries are a quite sensitive topic for agriculture. It is therefore possible that the farmers may have based their answers in the offline survey more on what is desirable on the part of the profession, which is more likely to be the preservation of arable land. The true WTA will probably lie in between, which we have taken into account by using the average of the two.

In general, the amounts of WTA can also significantly exceed the BRW of the measure area. Interveners could therefore be motivated to buy the arable land instead of the ecopoints and implement the measure themselves. However, the implementation itself also leads to costs and the availability of land for purchase can be very limited. However, the acquisition of ecopoints can be advantageous for the intervener due to a limited availability of land and a time advantage, which can be considerable for construction projects.

Our derived price ranges per ecopoint for the conversion of arable land into grassland and nature conservation appear to be quite realistic in comparison with a practical case from Baden-Württemberg, where ecopoints generated in the forest were sold at 0.80 € (Enssle, 2014). Depending on the location of the measure, the price range is usually between 0.50 € and 1.10 € (Mössner, 2019). However, it should be noted that this price range is pre-tax, whereas our prices were calculated after tax. Therefore, our prices are rather too low, but this does not exclude a certain overlap with the given price range above. Furthermore, the WTAs are mean values over all participants in the study. Our analyses also showed that farmers who do not farm organically, have no farm successor and own land with low standard land values, could be the ideal partners from an economic point of view for the implementation of compensation measures. In the context of PIC we can confirm the findings by Le Coent et al. (2017) that there is a need for a greater financial incentive for organic farms to implement biodiversity offsets. For example, in the dataset for Rhineland-Palatinate there are farmers without a farm successor who do not farm organically and who have chosen the alternative of implementing PIC in combination with a land register entry for an annual compensation payment of 1000 €, i.e. less than 1 € per ecopoint for PIC. Thus, there are also farmers with a lower WTA. Trade in ecopoints would then probably be concentrated on this group. In general, we found that PIC would be more expensive for the intervener than a complete transfer to nature conservation. Hence, the transfer of agricultural land to nature conservation could also be implemented more cost-effectively in some cases.

Some limitations of the methods used should be kept in mind when interpreting the results. As mentioned above, the results are not representative for the whole population of German farmers and are based on hypothetical decisions. In addition, a large volume of the data was generated during on-site events, which may give rise to some bias, as farmers who are more interested and open to the issue may have been more likely to participate. With regard to the decision-making behaviour of farmers, the predictive accuracy of the model could be further improved. It cannot, therefore, be ruled out that there are other relevant attributes that were not part of the choice set. In addition, the standard errors of the parameter estimates for the attributes indicate a certain preference heterogeneity between farmers in general. The heterogeneity could possibly have been better investigated with further recorded covariates. We did also not focus on further individual conditions of the field site, for instance the distance to the farm or field shape, which might also have impact acceptance. Furthermore, the farmers had to assume that the field in the choice set is a concrete field on their farm. For this reason, some of them had to anticipate higher maximum losses in the value of the area or standard soil values than might be usual in their region. With regard to the compensatory measures, mention must also be made of the fact that PIC was only considered here in a very general form. Indeed, there are many and sometimes very different PIC measures. As a result, acceptance could also differ again depending on the specific measure. When interpreting prices per ecopoint, it must also be borne in mind that the number of points and potential loss of yield may also vary depending on the specific measure. Therefore, the calculated prices per ecopoint give only a first orientation on the example of one federal state.

5. Conclusions

As compensation measures or biodiversity offsets are increasingly being implemented in many countries worldwide, the experiences of individual countries can provide valuable input for the general discussion (Brownlie et al., 2017; Darbi, 2020; Wende et al., 2018). Often, the type and planning of compensation measures are part of the discussion, and many recent studies address the ecological impacts of the concrete location and aggregation of compensation measures on a landscape scale (Bigard et al., 2020; Gordon et al., 2011; Kiesecker et al., 2010; Tarabon et al., 2020a, 2020b). Biodiversity offsets are often analysed from an ecological perspective, but the minority of recent studies has focussed on social aspects, for instance relevant stakeholders or policy, which is essential for the success of the scheme (Gelcich et al., 2017). From this point of view, agriculture in particular is a relevant stakeholder with regard to the provision of land and the maintenance of measures (Primmer et al., 2019). In addition, the conversion of agricultural land for compensation purposes in connection with long-term legal protection is often discussed in the context of biodiversity offsets (ten Kate and Crowe, 2014). The interests and preferences of farmers could therefore be particularly important in the large-scale planning of compensation measures at regional level and in reducing potential land use conflicts between agriculture and nature conservation in general. We were able to provide some insights into the market for biodiversity offsets from the perspective of agriculture in general, and we were able to show how eco-accounts with farmers can be set up in a more targeted way. Hence, our study also contributes to other studies dealing with the transparency and mechanisms of markets for biodiversity offsets (Alvarado-Quesada et al., 2014; Koh et al., 2019; Needham et al., 2019). In our view, agriculture can be a relevant player in this market and there is certainly potential for synergies with other EU policy objectives, such as the EU Biodiversity Strategy (European Commission, 2020). Using a DCE approach, we were able to analyse farmers' preferences for compensation measures and to obtain economically robust estimates according to their willingness to accept (WTA). In general, farmers are willing to implement compensation measures voluntarily on arable land. This could be of great importance when implementing appropriate nature conservation compensation measures in urban areas. Besides monetary compensation, the type of measure and the form of legal protection in connection with an infinite duration of the measure are other important factors. Farmers are more willing to accept PIC as an extensification of farming than other measures. Nevertheless, the results show that PIC can be actually most beneficial when there is no requirement of a land register entry and the maintenance period is limited, for instance to 25 years. Otherwise, the costs in relation to the nature conservation enhancement, for instance assessed in ecopoints per m^2, are high in comparison to other measures. From our analysis we cannot recommend that policy makers devote substantial resources to developing a legal framework for measures with a maintenance period of less than 25 years, since there was no significant effect on acceptance within this time frame. As an alternative to the entry in the land register for the area of measures, a further area with an already high nature conservation value could be permanently secured, possibly under the Bavarian Ordinance on Compensation for Interventions in Nature and Landscapes (BayKompV). However, the quasi double search for land could prove to be difficult and possibly lead to renewed competition for land. Finally, it must of course be borne in mind that PIC often also means a certain loss of agricultural land, e.g. flower strips, field edge strips etc. (Fischer-Hüftle, 2011). If an area is completely transferred to nature conservation, 1.2 ecopoints could be generated for every 1% loss in yield according to our estimates. With the PIC measure we assume the ratio would therefore be lower with 0.8 instead of 1.2. In this case, agriculture would lose more productivity with PIC. However, PIC can also be used to achieve a high degree of spatial impact, as many areas are upgraded to a minor degree. In addition, PIC might be also a desirable option for temporary interventions, for instance for areas which are needed temporarily due to construction work. Furthermore, PIC can probably be used in the field of species protection, e.g. for partridges (Perdix perdix), since a higher number of ecopoints can be generated by this combination. In this case, agriculture could even gain more productivity in comparison to other compensation measures. Buner et al. (2005) concluded that a mosaic of permanent wild-flower strips could be a key component in agricultural landscapes to ensure the survival and reproduction of field birds like the partridge (*Perdix perdix*), even in a small proportion. Goldmann et al. (2007) conclude that the activity of farms needs to be coordinated across landscapes to ensure the supply of certain ecosystem services, e.g. pollination, as this cannot normally be achieved just by individual farmers. In this context, too, Samway et al. (2010) found that 'ecological networks' on a larger scale in the landscape are crucial for biodiversity conservation. Especially for species with a large range, environmental management has to be established on a landscape level and not at the individual farm level (Franks, 2011). Instead of integrating compensation into land management as a form of land sharing, farmers could also make just a small part of a land parcel available for complete nature conservation, for instance permanent edge strips with lower productivity as it is does not make sense to use high productivity sites for compensation measures from the perspective of the economy and food security (Louis, 2010). These marginal areas could then be linked up to create larger habitats in order to collectively establish for instance 'green belts' with high nature values along paths as interconnected corridors. For this purpose, securing small areas in the land register could be sufficient and monetary income from production would still be possible on the remaining area of the field plot. In general, pursuant to § 1023 of the German Civil Code (BGB), a land register entry can also be limited spatially to a partial area of a field plot. According to Rabenschlag et al. (2019), small, isolated compensation areas without interconnections are generally an ongoing problem in the German compensation system in practice. In this context, we believe that sensible coordination would be necessary with regard to compensation measures in order to achieve ecological enhancement on a larger scale. Thus, it would probably also be possible to create high-quality habitats for different species in the landscape through effective coordination of PIC measures together with local administrations. On the one hand, this approach would mean a shared and relatively low burden on the individual farmers instead of a high economic impact on individual farms. On the other hand, individual areas could be given over permanently to nature conservation, which is the actual goal of the IMR. Josefsson et al. (2017) found that a collective form of agri-environmental schemes could also increase the farmers' commitment to implementing measures, which could possibly also be transferred to nature conservation compensation.

In order to minimise the loss of agricultural land, we would recommend the complete relinquishment of a few areas for nature conservation combined with a high degree of upgrading through sensible coordination of the measures within the framework of collective compensation forms. These areas should be integrated into agricultural landscapes in such a way that, on the one hand, they have a high nature conservation value and, on the other hand, cultivation of the remaining areas is not hindered or made more difficult. Perhaps we should define the term PIC more broadly than before to include a collective form of compensation. All in all, we believe that PIC – as a collective compensation form – is part of the solution to establish successful nature conservation in the agricultural landscape. We were able to demonstrate the conditions under which farmers are motivated to participate in nature conservation compensation schemes especially with PIC measures. Consequently, our study cannot address land use through development as the main cause of the loss of agricultural land, but it does contribute to the solution of potential land use conflicts. Nevertheless, there is still a need for research into whether this more collective approach could possibly minimise the overall burden on agriculture and lead to an increased benefit for nature conservation through compensation measures. Appropriate instruments must also be created to coordinate the compensation measures and activities of individuals in the landscape.

CRediT authorship contribution statement

Christian Sponagel: Conceptualization, Methodology, Data curation, Formal analysis, Investigation, Writing - original draft. **Elisabeth Angenendt**: Project administration, Funding acquisition, Writing - review & editing. **Hans-Peter Piepho:** Validation, Writing - review & editing, Formal analysis. **Enno Bahrs:** Supervision, Writing - review & editing, Funding acquisition.

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Data statement

The data are available on request from the corresponding author.

Declarations of interest

Declarations of interest: none.

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