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REVIEW

Adding Some Green to the Greening: Improving the EU's Ecological Focus Areas for Biodiversity and Farmers

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Keywords

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Abstract

Ecological Focus Areas (EFAs) are one of the three new greening measures of the European Common Agricultural Policy (CAP). We used an interdisciplinary and European-scale approach to evaluate ecological effectiveness and farmers' perception of the different EFA options. We assessed potential benefits of EFA options for biodiversity using a survey among 88 ecologists from 17 European countries. We further analyzed data on EFA uptake at the EU level and in eight EU Member States, and reviewed socio-economic factors influencing farmers' decisions. We then identified possible ways to improve EFAs. Ecologists scored field margins, buffer strips, fallow land, and landscape features as most beneficial whereas farmers mostly implemented "catch crops and green cover," nitrogen-fixing crops, and fallow land. Based on the expert inputs and a review of the factors influencing farmers' decisions, we suggest that EFA implementation could be improved by (a) prioritizing EFA options that promote biodiversity (e.g., reducing the weight or even excluding ineffective options); (b) reducing administrative constraints; (c) setting stricter management requirements (e.g., limiting agrochemical use); and (d) offering further incentives for expanding options like landscape features and buffer strips. We finally propose further improvements at the next CAP reform, to improve ecological effectiveness and cost-effectiveness.

Introduction

Agricultural intensification and land abandonment exert major pressures on farmland biodiversity and dimin-

ish ecosystem functions and services. The ongoing decline in biodiversity in and around farmland is a source of major concern both in Europe (EEA 2015) and globally (Maxwell *et al.* 2016). In the European Union (EU),

a key instrument that could help mitigate these trends is the Common Agricultural Policy (CAP). The CAP provides payments under two “Pillars”: “direct payments and market-related expenditures” (Pillar 1, circa €37 Billion/yr) and “Rural Development” (Pillar 2, circa €14 Billion/yr).

Since its first implementation in 1962, the CAP has been repeatedly reformed to reflect changes in societal demands. In response to the increasing demand for biodiversity conservation (Hodge *et al.* 2015), the latest reform of 2015 introduced a “greening” of Pillar 1. Consequently, 30% of the payment are now linked to one or more of three new greening measures (EC 2013a, Article 43): (a) crop diversification, requiring farms with arable land exceeding 20 or 30 hectares to grow at least two or three crops, respectively; (b) maintenance of permanent pastures, allowing only for a maximum loss of 5% by 2020; and (c) promotion of Ecological Focus Areas (EFAs), requiring farms with arable areas exceeding 15 hectares to dedicate 5% of such areas to ecologically beneficial elements as defined by the European Commission (EC). Such elements include landscape features such as terraces, hedges, or ponds, but also fallow land, nitrogen-fixing crops, and “catch crops and green cover” (EC 2013a, 2014; see Table 1). As the ecological value and implementation costs of different EFA options vary, the EC introduced weighting factors (see Table 2): for example, one hectare of landscape features is counted as 1.5 ha, whereas the same area of nitrogen-fixing crops is counted as 0.3 hectare. Each Member State (MS) had the opportunity to select which of the ten EFA options defined by the EC are eligible for their national direct payments. In addition, MSs may support other “equivalent measures” that offer a similar or greater benefit for the environment, as long as they are approved by the EC prior to implementation. Each farmer may then choose which EFA options and/or national equivalent measures to implement (Oppermann 2015).

Challenges for biodiversity and farmers

The new greening measures have been criticized by ecologists and environmental organizations for setting requirements that are too low to halt the loss of farmland biodiversity (Pe'er *et al.* 2014a), and for not selecting the most effective measures for conserving biodiversity under current financial constraints (Dicks *et al.* 2014; Sutherland *et al.* 2015). In addition, the introduction of new greening measures resulted in increased administrative burdens for farmers and authorities, and therefore simplification of CAP's implementation will play an important role in its upcoming mid-term review, scheduled for March 2017 (European Council 2015).

Consequently, while the general public largely supports the CAP greening (EC 2016c), it is essential to assess whether its current design and implementation can yield significant positive impacts on biodiversity while being practicable for farmers. The recent release of reports by each MS on the implementation of CAP greening measures in 2015 provides a unique opportunity to do so.

Objectives of this article

This article examines how greening measures are currently designed and implemented, and how they could be improved to the benefit of both biodiversity and farmers. We focus here on Ecological Focus Areas (EFAs) because they represent a new element of the CAP whose effects on biodiversity are poorly documented. Furthermore, EFAs are likely to be subjected to reforms during the 2017 mid-term review, including the expansion of EFAs from 5% to 7% of arable land, and will likely remain part of the policy mix for the CAP beyond 2020. It is therefore critical and timely to assess the current design and implementation of EFAs and propose recommendations to improve their effectiveness for biodiversity while overcoming possible implementation barriers for farmers.

This article presents an interdisciplinary evaluation of the various EFA options, combining ecological experts' assessments on their potential effects on biodiversity with social scientists' review and evaluations of the factors influencing farmers' implementation decisions. To this end, we (1) conducted a European-scale survey among ecologists to assess potential biodiversity effects of EFA options; (2) collected data on farmers' uptake to examine on-the-ground EFA implementation; (3) synthesized expert opinions and a review of the factors influencing farmers' decisions; and (4) compared EFA options according to their impacts on biodiversity and their relevance for farmers to identify possible improvements of EFA design and implementation. Through this interdisciplinary and European-scale approach, we develop recommendations aiming to increase the uptake and best management of biodiversity-friendly options by farmers; reduce administrative burdens; and promote coherence between CAP and EU's nature conservation goals.

Methods

The conceptual framework of this study was developed over three interdisciplinary workshops between June and September 2015 (see Supporting Information [SI] 1). The spectrum of methods chosen included:

- (1) **Ecologists' evaluation of EFA impacts on biodiversity:** We conducted a survey among

Table 1 Overview of the options defined by the EU as eligible for EFAs, alongside the weighting factor defined by the EC for a given area taken up for each option, and the number of MSs implementing each EFA option (= "Num. MSs")

Category	Description	Weighting factor	Num. MSs
(a) Fallow land	Land without any crop production or grazing, but maintained for production in the following years.	1.0	26
(b) Terraces	Terraces without use of pesticides.	1.0	8
(c) Landscape features	Elements subject to cross-compliance like hedgerows, single trees, rows or groups of trees, boundary ridge, ditches, other landscape elements.	See below	24
(d) Buffer strips	Strips without productive use alongside a watercourse adjacent to a field or within a field higher upon a slope.	1.5	17
(e) Agro-forestry	Land-use systems in which trees are grown in combination with agriculture on the same land with a maximum number of trees per hectare.	–	11
(f1) Strips along forest edges – with production	Strips of arable land adjacent to forest, with production but limited agrochemical inputs; with a width between 1 and 10 meters.	0.3	5
(f2) Strips along forest edges – without production	Strips on arable land adjacent to forest, without production; with a width between 1 and 10 meters.	1.5	9
(g) Short rotation coppice	Production of wood with specific, fast growing tree species.	0.3	20
(h) Afforested areas	Areas with afforestation on former arable land (in most cases supported by Pillar 2 measures).	1.0	14
(i) Catch crops, or green cover	Catch crops are a mixture of productive crops and/or grass following a productive crop to protect soils and use available nutrients during the winter.	0.3	19
(j) Nitrogen-fixing crops	A list of productive leguminous plants	0.3 (DE: 0.7) ^a	27
Specific landscape features:			
Hedges	Hedges or wooded strips (width up to 10 meters).	2.0	
Isolated trees	Isolated trees with a crown diameter of minimum 4 meters.	1.5	
Trees in lines	Trees in line with a crown diameter of minimum 4 meters. Space between crowns shall not exceed 5 meters.	2.0	
Trees in groups	Trees in group, where trees are connected by overlapping crown cover, and field copses of maximum 0.3 ha in both cases.	1.5	
Traditional stone walls	Wall with a length of minimum 5 meters that are not part of a terrace.	1.0	
Ditches	Ditches with a maximum width of 6 meters, including open watercourses for irrigation or drainage (excluding channels with concrete walls).	2.0	
Ponds	Ponds of up to 0.1 ha (excluding reservoirs made of concrete or plastic).	1.5	
Field margins	Field margins with a width between 1 and 20 meters, with no agricultural production.	1.5	

^aIn Germany, the weighting factor for nitrogen-fixing crops is 0.7, using the flexibility allowed by EC delegated regulation (EU) No 639/2014. Source: EC 2014.

ecologists in the EU and Switzerland working on biodiversity in agro-ecosystems. As potential experts we considered persons who perform ecological research, monitoring or conservation management in agricultural landscapes or farmland areas. Familiarity with at least some of the features eligible for EFAs was required, while policy knowledge was not. Experts were identified as such by workshop partici-

pants or suggested by other respondents to our survey (i.e., a snowball approach). In total, invitations to complete the survey were sent to circa 310 experts, asking them to only fill out the survey if they felt they had sufficient expertise in the subject area. Respondents were asked to state their area of expertise (geographic, methodological, and taxonomic) and assess the impacts of EFA options for up to three

Table 2 Share of the different Ecological Focus Area (EFA) options taken up (a) at 8 MSs and the EU level, and, (b) in the different federal states of Germany (shares of area are in % and before applying weighting factors)

a) Member State									
	Fallow land	Buffer strips	Landscape features	Catch crops and green cover	Nitrogen-fixing crops	Short rotation coppice	Afforested areas	% EFA (absolute)	% EFA (weighted)
Share of Ecological Focus Area (in per cent) ^f									
Germany	16.2	1.2	2.4	68.0	11.8	0.2	0.1	11.5	5.8
Austria	19.1	n.a. ^d	0.03 ^c	32.3	47.9	0.7	n.a.	–	–
Czech Republic	5.4	0.5	0.08	33.4	60.5	0.03	0.06	–	–
Denmark	7.6	6.0	0.3 ^b	84.6	n.a.	1.5	n.a.	–	–
England	33.1	1.0	4.7 ^a	5.5	55.8	n.a.	n.a.	–	–
Estonia	25.5	n.a.	2.0	n.a.	72.5	n.a.	n.a.	–	–
The Netherlands^g	n.a.	1.8	n.a.	95.1	3.1	0.01	n.a.	–	–
Poland^h	4.7	0 ^h	0.4 ^h	57.4	36.6	0.2	0.8	16.8	8.8
European Union (EU)^e	21.2	0.7	4.3	27.7	45.4	0.2	0.6	14.0	9.0
b) German federal state									
	Fallow land	Buffer strips	Landscape features	Catch crops and green cover	Nitrogen-fixing crops	Short rotation coppice	Afforested areas	% EFA (absolute)**	% EFA (weighted)**
Share of Ecological Focus Area (in % before applying weighting factors)									
Baden-Württemberg	11.4	0.6	0.3	70.6	17.0	0.1	0.0	12.1	5.6
Bavaria	12.9	0.9	0.4	72.1	13.4	0.1	0.0	11.5	5.2
Brandenburg*	29.7	0.6	1.8	48.0	19.0	1.0	0.0	11.0	6.7
Hessen	28.6	1.2	0.5	60.8	8.9	0.0	0.0	9.6	5.3
Lower Saxony*	8.7	0.6	0.6	87.5	2.6	0.1	0.0	15.4	5.8
Mecklenburg-Vorpommern	29.2	3.2	3.3	57.0	5.9	0.0	1.4	10.0	6.2
North Rhine-Westphalia	6.8	1.6	1.2	87.1	3.4	0.1	0.0	15.0	5.9
Rhineland-Palatinate	33.0	0.9	1.1	55.4	9.6	0.1	0.0	10.4	6.1
Saarland	46.3	1.9	5.3	37.0	9.4	0.1	0.0	6.0	4.5
Saxony	13.9	1.2	1.0	64.1	19.5	0.1	0.3	11.1	5.6
Saxony-Anhalt	26.1	0.8	1.1	47.7	24.2	0.1	0.1	10.0	6.0
Schleswig-Holstein*	9.4	3.3	47.7	35.7	3.7	0.1	0.0	5.9	6.0
Thuringia	18.5	2.3	1.4	35.9	41.9	0.0	0.0	9.0	5.8
Germany	16.2	1.2	2.4	68.0	11.8	0.2	0.1	11.5	5.8

Source: Results for MSs were reported by national Ministries for Agriculture from October 2015 until February 2016. EU-wide results were reported by the EU Commission in June 2016.

^aEngland: Hedges.

^bDenmark: Ponds and archaeological sites between 0.01 and 0.2 ha.

^cAustria: Ponds and ditches are offered as landscape features.

^d"n.a.": measure not approved in that MS.

^ePreliminary Data for all MSs except France.

^fShare of area before applying weighting factors.

^gThe "collective approaches" to EFA and the "Skylark-Program" are not included in the figures.

^hIn Poland, the figures for some of the landscape features and buffer strips were only available in "linear meters," not in hectares. So for these two options, the presented EFA share is probably slightly underestimated.

Source: German Ministry for Food and Agriculture (BMEL) 2015b.

*The city-states Berlin (BE), Bremen (HB), and Hamburg (HH) were added to Brandenburg, Lower Saxony, and Schleswig-Holstein, respectively.

**Note that because of the weighting factors employed, the total area of EFAs cannot be interpreted based on the presented shares (in percentage). For raw numbers (in area) see Table S5 in SI 4.

"groups" defined by taxon and habitat affiliation (e.g., forest birds, grassland butterflies). Experts then scored the effects of each EFA option on each "group," in their view, from +5 (very positive) to -5 (very negative) or "mixed effects." Experts were also asked to identify conditions under which each EFA option could most benefit biodiversity (e.g., agricultural management, spatial design, vegetation composition, implementation duration, structural maintenance, and other). For further details on the methods and profile of the respondents, see SI 1. For an overview of the recommendations, see SI 2.

The answers of the experts were analyzed using descriptive statistics (mean, median, quantiles, and 95% CIs). We used the average score to define an ecological "win" (average > 1), "lose" (< -1), or "mixed" (-1 < average < 1). This assignment was verified against the three quartiles of score values, identifying the number of cases above, at, or under 0, as well as by inspecting the frequency distribution of scores. We refrained from conducting significance tests due to the high variance in score values (see Figure 1), related to regional and taxonomic differences which are beyond the scope of this study.

2 Statistics on the implementation of EFAs in

2015: We asked agricultural ministries across MSs for data on the number of farmers and total area registered under each EFA option in 2015. We considered that these uptake levels represent good indicators of farmers' preferences. We received data from eight MSs: Germany, Estonia, The Netherlands, Denmark, Austria, Czech Republic, England, and Poland as well as a preliminary data at the EU level based on all MSs except France (EC 2016b). We defined EFAs as "win" (+) and "lose" (-) based on high or low uptakes at the EU level, assuming that these indicate attractiveness from the farmers' perspectives. This assignment was confirmed through interviews with farmer representatives in a complementary study (Zinngrebe *et al.* submitted).

We obtained additional data on variations in farmers' uptake levels across German federal states, including (a) the total cover of each EFA option declared in 2015 compared to the total Utilized Agricultural Area (UAA), and (b) the total cover of nitrogen-fixing crops and fallow land over time since 2004.

3 Expert knowledge on factors influencing farmers' uptake:

We collected inputs during the three workshops on the determinants that may influence farmer's EFA decisions. At the third workshop, we structured these inputs, and divided these determi-

nants into three categories: economic determinants, administrative conditions, and farm-level management. These categories were used to guide a literature review of >30 publications in English and German (both peer reviewed and gray literature), to aid interpreting the implementation statistics, and thereby, gaining a better understanding of farmer's preferences and constraints.

4 Synthesis and collation of recommendations:

We compared EFA options according to both their impacts on biodiversity and their uptake by farmers, to identify different categories of EFA options ("win-win," "win-lose," etc.). Based on this simple categorization, combined with the expert opinions provided during the workshops and survey, we then developed recommendations on the ways to mitigate potential trade-offs and conflicts.

We note that ecologists participating in our surveys focused on above-ground biodiversity, and particularly farmland biodiversity. Less attention was also given to biodiversity in forested areas. We did not analyze geographical differentiation in scoring values, nor impacts of EFAs on ecosystem services, as these aspects were beyond the scope of this study.

Results

EFA impacts on biodiversity

We received 88 expert responses to our survey, from 16 MSs and Switzerland. The number of responses varied among EFA options, ranging from 67 for catch crops to 87 for landscape features. Taxonomic expertise included birds, plants, arthropods, mammals, amphibians, and reptiles. Scores were associated with high variance for some EFA options (e.g., afforested areas, agroforestry, or terraces), probably as a result of taxonomic and geographic differences, as well as differences on how envisioned practices were implemented in detail (Figure 1). Overall, buffer strips, fallow land, and landscape features received mostly positive scores, while agroforestry, afforestation, and short-rotation coppice received generally negative scores in terms of their perceived impact on biodiversity (Figure 1). Among landscape features, hedges, field margins, and traditional stone walls received the highest scores (Figure 1). All options apart from catch crops and short-rotation coppice were considered to have an overall positive effect on generalist species, whereas specialist species were considered to benefit primarily from fallow land, buffer strips, and landscape features (Figure 1C). Fallow land and buffer strips were considered to benefit farmland species, while landscape features and nitrogen-fixing crops had more variable scores (Figure 1D).

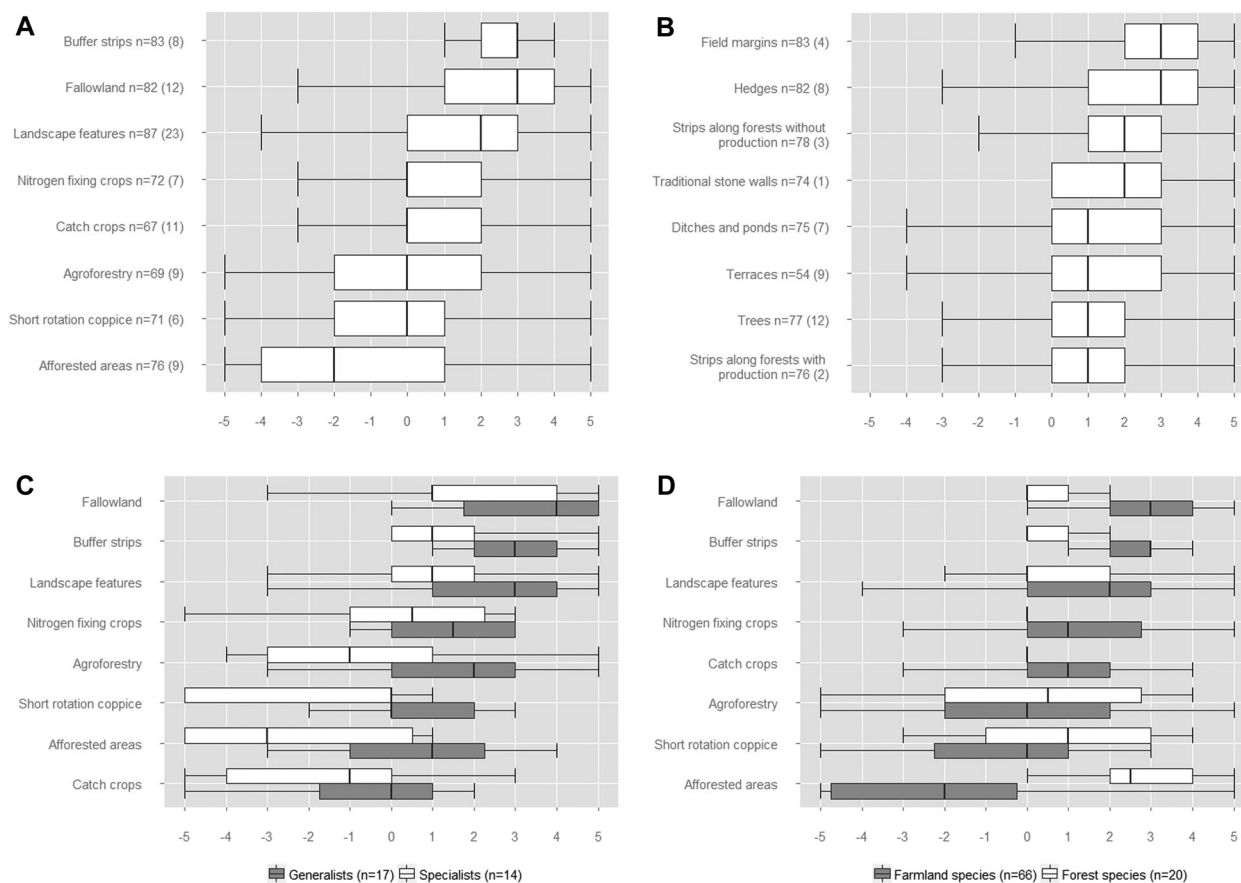


Figure 1 Outcome of EFA scoring by ecologists (A) for all EFAs, (B) for every type of landscape feature, (C) categorized based on specialization of assessed groups into generalists versus specialists, and (D) categorized based on habitat affiliation (forest versus farmland species). Box plots depict the medians, quantiles, and standard deviation. N is the number of experts assessing a given EFA or species' group. The number of experts reporting "mixed" effects is given in brackets for (A) and (B).

Despite an overall negative score, afforested areas were scored as benefitting forest species (Figure 1D).

EFA implementation in 2015

The number of EFA options eligible for implementation varied between MSs: 14 MSs approved >10 EFA options, 9 MSs approved between 5 and 9 options, and 5 MSs approved ≤ 4 options. Nitrogen-fixing crops, fallow land, and landscape features were taken up by the largest number of MSs (Table 1). Overall in the EU, farmers registered 16% of the arable land as EFAs, equivalent to 10% after applying weighting factors (Table 2). Three EFA options accounted for the vast majority of EFA cover: nitrogen-fixing crops, "catch crops and green cover," and fallow land. In most MSs assessed, landscape features had a very low uptake, as did buffer strips. Implementation levels varied both among and within MSs.

Nitrogen-fixing crops had a share of 46% across the EU but ranged in the assessed MSs from 3% (The Netherlands) to 73% (Estonia). Catch crops (27% at EU level) ranged from 6% to 95%, while fallow land (21%) ranged from 5% to 33% (Table 2). In Germany, "catch crops and green cover" represented the main EFA option (68% of total EFA), but uptake levels were particularly high in the federal states of Lower Saxony, North Rhine-Westphalia, Bavaria, and Baden-Württemberg (Table 2). Landscape features made up only 2.4% of the EFA area on average in Germany, but 48% in Schleswig-Holstein. The area of nitrogen-fixing crops and fallow land in Germany increased by 74% and 62%, respectively, between 2014 and 2015 (Figure 2), indicating a direct impact of EFA implementation. Nevertheless, the area of fallow land and nitrogen-fixing crops remains considerably smaller than during the obligatory set-aside policy of the CAP prior to 2008 and the support of leguminous plants in the 2000s

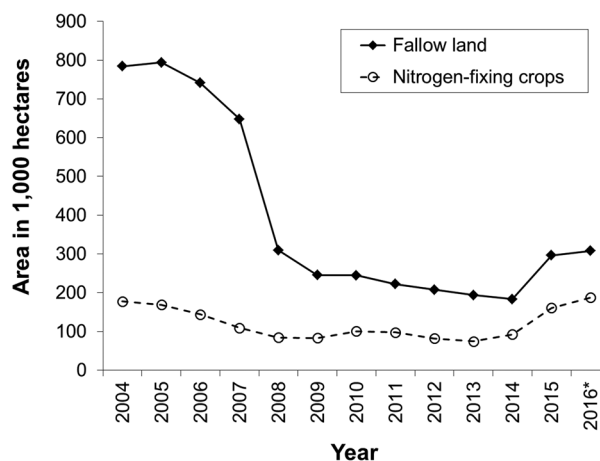


Figure 2 Cover of fallow land and nitrogen-fixing crops in Germany through the years 2004–2016. Source: Destatis 2005–2016. * Note that the data for 2016 are preliminary.

(Figure 2). Also, it is estimated that only 15.1–41.5% of the existing landscape features and buffer strips in Germany were registered as EFAs in 2015 (Isermeyer *et al.* 2014, p. 15).

Determinants of uptake among farmers

Our literature review identified multiple theories and approaches which can be used to explain farmers' decision-making (Ajzen 1991; Van der Ploeg 1994; de Snoo *et al.* 2013; Home *et al.* 2014). Following Lange *et al.* (2015), we clustered determinants into three key categories: economic determinants, administrative restrictions, and farmers' perceptions and knowledge (see also Table 3).

(a) Economic determinants

Economic considerations, including minimizing the production, opportunity, and/or transaction costs, are central for farmers when evaluating policies. Farmers perceive greening restrictions as costly (Schulz *et al.* 2014) and therefore tend to choose the most productive and cheapest options (Lakner & Holst 2015). Consequently, 73.1% of the total EFA-area in the EU is covered by "productive options" (EC 2016b; see also Table 2). Economic considerations also tend to favor existing features (e.g., the high registration of landscape features in the federal state of Schleswig-Holstein, Table 2), as well as practices that are easy to implement. This is reflected by the large proportion of "catch crops and green cover" in some MSs (Table 2). Land productivity, expressed in costs of land rent, affects EFA choices too. For instance, higher uptake of fallow land in Germany occurred in

federal states with lower land-rental prices and usually lower productivity, indicating low opportunity costs (see **Figure S1** in SI 3). Production costs and opportunity costs for land use, but also transaction costs and property rights, limit the establishment of new landscape elements such as hedges (Schleyer & Plieninger 2011). Finally, for economic reasons the expectation is that most farmers will not abandon the system of direct payments, since the implementation costs are clearly below the received greening payments (Heinrich 2012; de Witte & Latacz-Lohmann 2014; Schmidt *et al.* 2014; Lakner & Bosse 2016; Lakner *et al.* 2016).

b) Administrative restrictions

The implementation of EFAs by farmers is controlled by authorities, and might lead to sanctions if rules are broken. For example, there are strict minimum and maximum widths allowed for buffer strips in Germany (BMEL 2015a). This creates a relatively high risk of repayment or fines due to inaccuracies in the measurement of strip size or width by either farmer or authorities. Thus, although this option is generally economically viable (de Witte & Latacz-Lohmann 2014; Schmidt *et al.* 2014; Lakner & Bosse 2016; Lakner *et al.* 2016), the legal restrictions translate into risk-related costs or transaction costs, which partly explain the low uptake of buffer strips and landscape features.

The low uptake of landscape features can also be explained by property rights. Often, ownership and hence the right to register a feature is unclear, or there can be multiple owners (e.g., Schleyer & Plieninger 2011; Hauck *et al.* 2016). The exceptionally high uptake of landscape elements in Schleswig-Holstein may be explained not only by their unusual prevalence, but also by clearly defined land-property rights compared to other German regions. Landscape features in Germany and other countries are also subject to overlapping regulation, such that in many cases landscape features require safeguarding under the cross compliance (CC) rules of Pillar 1 (EC 2009, article 6; 2016a) or the EU's Habitats Directive. This increases the control risks for farmers, making them reluctant to register, restore, or establish new landscape features.

c) Farmers' perceptions and knowledge

Traditional land-use and established farming practices influence EFA decisions. For example, hedges in Schleswig-Holstein ("Knicks") are part of the traditional farming system and landscape going back into the 18th century (Beyer & Schleuß 1991). Their protection is consequently both pragmatic (as boundary structures) and culturally beneficial (Piore & Reutter 2002). **Existing practices**, farm structures, available technologies,

Table 3 Synthesis of expert knowledge on factors influencing farmers' uptake, with examples for implications and outcomes of these factors

	Determinants	Implications and examples
Economic	Productivity	Higher uptake of productive EFA options (e.g., catch crops)
	Opportunity cost	Higher uptake of fallow land where rental prices are lower
Admin	Repayment risk	Width of buffer strips hard to measure → low uptake
	Property rights	Unclear ownership of landscape features → low uptake
Perception	Traditions	High coverage of hedges in Schleswig-Holstein
	Experience	Higher uptake of nitrogen-fixing crops in Eastern Germany
	Personal attitude	Strong variations in EFA preferences between farmers

and established management experiences can influence farmers' EFA choices too (Schulz *et al.* 2014). For instance, growing nitrogen-fixing crops such as beans and peas requires specific knowledge and particular harvesting equipment. This translates into a higher uptake of these EFA options in Eastern Germany where the climate is suitable for these crops and farmers have more experience and better equipment for implementation.

The perception of "productivity" in land management is another important criterion for EFA decisions, going beyond pure economic reasoning, since many farmers maintain a **self-perception** as "producers" (Burton *et al.* 2008; de Snoo *et al.* 2013; Home *et al.* 2014), whose primary role is to ensure the provision of food for society rather than protecting biodiversity. Accordingly, EFA decisions show a clear preference for "productive" EFA options.

Literature concerning the uptake of Agri-Environmental Measures (AEM) and other programs aiming to enhance farmland biodiversity suggests that their uptake, as well as the sense of ownership, are influenced by personal attitudes, subjective norms, and social interaction and control (Burton & Wilson 2006; Defrancesco *et al.* 2006; Burton *et al.* 2008; Ahnström *et al.* 2009; Ahnström *et al.* 2013; Home *et al.* 2014; Sulemana & James 2014). For example, Lokhorst *et al.* (2014) found that a stronger ownership of conservation activities among farmers related to personal connectedness to nature and a self-perception as conservationists. Additionally, social pressure can influence on decision-making since farmers have an interest in maintaining their fields in a productive and "tidy" status as perceived by their peers and neighbors (Hauck *et al.* 2016).

Comparison of EFA options and recommendations for future improvements

We identified one EFA option that is a "win-win" for farmland biodiversity and farmers (fallow land), two "win-lose" options, beneficial for farmland biodiversity but unattractive for farmers (buffer-strips and landscape

features), two "mixed-win" options with limited or unclear benefits for biodiversity but favored by farmers (nitrogen-fixing crops and "catch crops and green cover"), two "mixed-lose" options (agroforestry and short-rotation coppice), and one "lose-lose" option (afforested areas) from a perspective of farmland biodiversity (Table 4). We did not find "lose-win" options (receiving strongly negative scores by ecologists but favored by farmers).

We obtained a total of 895 recommendations to improve the effectiveness of EFA (for a full overview see SI 2). Options with more positive scores received also a greater number of recommendations ($n = 70$ – 82 for buffer strips, fallow land, and field margins), while EFA options with lower scores received fewer recommendations ($n = 31$ – 42 for short-rotation coppice, afforested areas, and agroforestry). Most recommendations were related to the category "agricultural management" ($n = 286$), with a general call for setting management specifications ($n = 107$), limiting the use of agrochemicals ($n = 72$), and defining specific harvesting and mowing regimes ($n = 52$). Within the category "spatial design" ($n = 264$), the most frequent recommendations were a general call for design and location properties ($n = 88$), the importance of defining a size or area ($n = 63$), and the potential benefits of combining buffer strips or landscape elements with other EFA options ($n = 42$). For the category "vegetation structure and composition" ($n = 262$), the majority of recommendations called for plant composition ($n = 219$), specifically mentioning the importance of plant diversity ($n = 69$), native plants ($n = 47$), and the support of flowering species ($n = 38$).

The need to consider the duration of EFA implementation was also mentioned, in particular for fallow land ($n = 11$).

Discussion

Our study indicates a mismatch between EFA design and implementation, where most EFA options that were

Table 4 Comparison of EFA options according to their score by ecologists (Figure 1) compared to their uptake by farmers (Table 2) as a measure of attractiveness. We defined an ecological win (+), lose (-) or mixed effects (\pm) based on the average and 3 quartiles (25, 50, 75%) of their score; while defining win or lose for farmers' implementation based on the share of the different EFA in the EU

	Ecologists scores		Farmers uptake		Biodiversity vs. Farmers perspective
	Average score		EFA in the EU [%]		
Fallow land	2.4	+	20.8	+	win - win
Buffer strips	2.5	+	0.6	-	win - lose
Landscape features	1.6	+	4.3	-	win - lose
Nitrogen-fixing Crops	0.7	\pm	46.2	+	mixed - win
Catch crops & green cover	0.4	\pm	27.2	+	mixed - win
Agroforestry	-0.1	-	n.a.	-	mixed - lose
Short-rotation coppice	-0.4	-	0.8	-	mixed - lose
Afforested areas	-1.4	-	n.a.	-	lose - lose

considered beneficial to biodiversity had low uptake among farmers. Moreover, we observed that the proportion of EFA surfaces registered were higher than the 5% currently required, with an EU-average of > 10%. Consequently, our study suggests that increasing the required EFA surface from 5% to 7%, as currently discussed in the context of the mid-term review, is unlikely to yield significant improvements in terms of EFAs' contribution to biodiversity conservation. Instead, efforts should rather focus on improving EFA option design and implementation, considering biodiversity, the determinants of farmers' decisions, and current obstacles to EFA implementation.

Improving EFA implementation in the current framework: recommendations for the 2017 mid-term review

The upcoming mid-term review of the CAP, scheduled for 2017, can be used to address implementation issues within the current legal framework. Accordingly, we first provide five major recommendations for improving EFA effectiveness for biodiversity within the current regulatory framework.

(1) Prioritize EFA options with clear benefits for biodiversity and reduce incentives for less effective ones. This could be achieved by

- **Ensuring that MSs approve effective EFAs:** Some EFA options that were scored highly by ecologists were not approved by all MSs (EC 2015a, p. 13). The MSs that did not include fallow land (the only "win-win" option), buffer strips, and especially the four MSs that did not approve landscape features, should be encouraged to revise their decisions.

- **Reconsidering ineffective EFA options:** Five EFA options were found to have mixed or even negative effects on farmland biodiversity. While they may support other environmental objectives beyond biodiversity (such as soil retention or carbon sequestration), they need to be employed under careful management criteria, limited to a maximum area at the regional or national level (see, e.g., The Netherlands with 95% catch crops), or even considered for removal to reduce competition with more effective EFA options. This may also help simplifying implementation. We also note that short-rotation coppice, agro-forestry, and afforestation are already promoted through other policies including AEMs.
- **Expanding the use of equivalent measures:** Equivalent practices have been developed by only five MSs to adapt greening to specific farming systems and environmental priorities, and none has taken a regional approach (Hart 2015). Implementation barriers could be reduced through local governance fora, integrating regional knowledge, stakeholder interests, and scientific expertise (Dosch & Schleyer 2005).
- **Adapting weighting factors** to the ecological value and implementation costs and benefits of each EFA option: Particularly, the weighting factors for catch crops and green cover and for nitrogen-fixing crops should be reduced as these options are easy to implement with little or no costs, while having unclear or small benefits for biodiversity.

(2) Reduce farmers' administrative burdens
Reducing administrative burdens could enhance the uptake of EFA options that are otherwise avoided,

such as buffer strips and landscape features ("win-lose"). This could be achieved by:

- **Simplifying technical requirements and relaxing sanctions:** Reducing and simplifying some technical requirements of biodiversity supporting EFAs, such as buffer strip widths and landscape feature area calculations, could significantly incentivize their uptake. Furthermore, sanctions can be relaxed if they emerge from innocent errors, such as mapping mistakes or area miscalculations that may not impede EFA aims.
 - **Increasing capacities for administrative support and ecological advice:** Stronger support provided by authorities would contribute to increasing farmers' confidence in effective EFA options. Particularly, funds are now available for Farm Advisory Systems (FAS) in Pillar 1, but they should be further developed in terms of their capacity to provide ecological knowledge and to communicate the benefits of some EFAs in terms of ecosystem services like erosion control, water quality, pollination, and pest control.
 - **Extending the eligible implementation duration of selected EFA options:** Under the current legislation, the status of buffer strips and fallow land (if continuously covered by grass-dominated vegetation) may change if implemented for more than 5 years, turning from arable to "permanent grassland." This change of status lowers land prices substantially and is legally difficult to reverse. To avoid these negative consequences, farmers usually convert buffer strips and fallow land back to arable land after 5 years, with potential loss of various benefits for biodiversity. Excluding EFA areas from this rule could enhance implementation duration, promote habitat stability over time, and improve the potential of these EFAs to contribute to landscape connectivity (SI 2; see also Henderson *et al.* 2000).
- (3) Set targeted and clear management requirements
Ecological experts provided a wide range of specific recommendations to improve the effectiveness of EFA options (for an overview, see SI 2). Notable recommendations are to **restrict the use of agro-chemicals**, and ensure a **high diversity of (eligible) plant species** while particularly supporting flowering plants.
- (4) Combine policy instruments
The protection, restoration, or creation of landscape features and buffer strips can be promoted by **offering top-up payments**, for example, through AEMs. Some German federal states already use additional

EFA-top-up payments with AEMs (see Lakner *et al.* 2016), albeit still with differing impacts.

- (5) Improve transparency of the implementation process

The European Commission so far has not published any full or comprehensible dataset on EFA-uptake at the MS level (for example, we used data primarily from cooperating ministries). Greater transparency, by publishing the implementation data yearly, can promote learning and improvements, as well as cooperation among stakeholders.

A vision beyond 2020

Our workshop discussions brought up five major points which should be considered in the next CAP reform in order to improve both ecological effectiveness and cost-effectiveness (see also **Table S4**).

- (1) Revise exemptions
Currently, farms with less than 15 ha arable land or farms with permanent crops are exempt from EFAs. This exemption should be revisited to improve the ecological effectiveness of EFAs (see **Table S4**).
- (2) Reduce windfall-gains to improve cost-effectiveness
Currently, 54% of EU farmers face minimal or no additional costs by these measures (EC 2011, pp. 9, 17), thus functioning as so-called "windfall-gains," i.e., payments for which no additional effort is taken toward the provision of a related service (in this case, biodiversity conservation). In some cases the premium level is well above the real production costs (or costs incurred), especially for catch crops (de Witte & Latacz-Lohmann 2014; Lakner & Holst 2015; Lakner & Bosse 2016). Consequently, there is much room for better differentiating payments based on actual costs and benefits.
- (3) Regionalize EFA design and implementation
Our expert survey highlighted an important need to adapt to local EFA settings from both ecological and socio-economic perspectives, by accounting for geographical, societal, and socio-economic specificities, as well as administrative scales (Lehmann *et al.* 2009; Prager 2015b). Recommendations included the following points:
- **Adopt EFA requirements to socio-economic and ecological conditions:** Cost-effectiveness is reduced by ignoring the very marginal production and opportunity costs not only among EFA options but also, for each option, in terms of the immense heterogeneity among farms and farmers across the EU alongside their diversity of interests, motivations, and attitudes toward biodiversity

protection (see, e.g., Schmitzberger *et al.* 2005; Wätzold & Drechsler 2014).

- **Support landscape-targeted and collaborative implementation:** Experiences from AEMs demonstrated that landscape-targeted AEMs are more effective (Tschardt *et al.* 2005; Wätzold & Schwerdtner 2005; Wrba *et al.* 2008; Merckx *et al.* 2009; Batáry *et al.* 2011; Prager 2015a; Tschardt *et al.* 2015). Similar spatial targeting should be applied to EFAs. This could be facilitated by local and regional authorities, and supported through Farm Advisory Systems and local governance fora.
 - **Reconsider EFA requirement levels at the regional level:** The current option for MSs to reduce the requirement for EFA from 5% to 2.5% in regions with high proportion of forests or protected areas entails that less strict requirements are set for areas where (semi-)natural elements are more abundant and hence, at least from a landscape-ecology perspective, EFAs could be particularly beneficial for biodiversity, for instance, by improving landscape permeability and connectivity.
- (4) Enhance cooperation between administration, extension services, and farmers
- Cooperation between stakeholders can act to increase uptake of biodiversity-friendly EFA options and improve their practical implementation. It could be achieved by
- **Adapting administrative structures to enable collective implementation:** Collective implementation might provide a range of advantages as farmers can jointly achieve more ambitious targets across spatial and temporal scales and reach critical ecological thresholds such as habitat size (Pe'er *et al.* 2014b) and connectivity. Yet only two MSs (The Netherlands and Poland) allowed farmers to implement EFAs collectively, providing incentives for contiguous EFAs (Hart 2015); and in 2015, only 45 farmers used this option (EC 2016b, Part 3/6, Annex II, p. 43). These examples demonstrate an underused potential to improve the environmental benefits of EFAs, as well as a need to assess whether collective implementation can indeed achieve its desired impacts.
 - **Promoting integrative and participatory approaches:** By supporting integrative and participatory conservation planning, platforms for knowledge exchange and local governance fora, the EU and MSs can promote synergies between sectoral interests, cooperation among stakehold-

ers, and more (cost-)effective use of knowledge (Dosch & Schleyer 2005). Furthermore, bottom-up initiatives can help achieve desired ecological and socio-economic goals that may otherwise seem administratively unfeasible (Prager 2015a,b).

(5) Enhance policy integration

Policy integration (*sensu* Runhaar *et al.* 2014) of all three greening measures will need to be carefully inspected in the next negotiations of the CAP regarding the EC's commitment to Policy Coherence for Development (PCD, EC 2015b), as well as CBD Aichi target 3 which requires signatory bodies to eliminate incentives harmful to biodiversity. Particularly, we recommend to:

- **Integrate the CAP with existing policies for farmland biodiversity conservation:** Recent assessments demonstrate limited coherence of the CAP with the Habitats and Birds Directives (Milieu *et al.* 2015). We further recommend inspecting its coherence with the EU's Green Infrastructure Strategy (European Parliament 2013).
- **Ensure that none of the greening measures supports biodiversity deterioration:** The permanent-grassland greening measure focuses on quantity while lacking quality requirements. The crop-diversification measure allows reducing the number of crops without meeting the threshold requirement of two or three crops (Pe'er *et al.* 2014a). Moreover, closer monitoring should be employed to ensure that (semi-)natural habitats do not deteriorate under the greening measures.
- **Use experiences from AEM implementation:** Overall, there is much room to use the experiences acquired in the application of AEMs within Pillar 2. Voluntary financial incentives, such as those provided by AEMs, often work better than regulatory mechanisms (Henle *et al.* 2008) and can be linked to result-based mechanisms that have been tested with some success (de Snoo *et al.* 2013). Overall, given the experiences and tools already existing in Pillar 2 AEMs, and considering the budget decline for Pillar 2 in the last CAP reform, the next reform should focus on restoring and even expanding Pillar 2, and within it the share of budgets earmarked for protecting biodiversity.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web site:

Table S1: Respondents' profile according to (a) country, taxonomic group of expertise, years of experience and (b) source of expertise.

Table S2: Type of recommendations and the number of experts making them, accompanied by an explanation of the content and/or the recommendation itself.

Table S3: Type of recommendations, and number of experts making them, (a) for each EFA option and (b) for each type of landscape feature.

Table S4: Synthesis of recommendations provided, by participants at the Round Table Discussion at the ICCB-ECCB conference in Montpellier.

Table S5: Area and share of registered ecological focus area across federal states in Germany, weighted according to the legal weighting factors (in hectares).

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