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COMPARING GREENING RULES AND ALTERNATIVES WITH REGARD TO INCOME EFFECTS AND PRODUCTION PATTERN

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Abstract

With the motivation to reduce pressures on natural resources, and biodiversity, in particular, the 2013 Common Agricultural Policy (CAP) reform introduced 'Greening rules', which farmers have to meet to receive a greening payment as part of their total CAP payment. Concerns have been raised by practitioners and scientists since, questioning the effectiveness and fairness of Greening. Yet empirical evidence for the effects of Greening is still insufficient. This paper examines how Greening and an alternative biodiversity oriented scenario affect the land use pattern and income of different farm types in three northern German regions (Diepholz, Uelzen, Oder-Spree). A bio-economic modelling framework is used to implement the scenario. The results show that Greening has only moderate impact on land use patterns and at the same time causes only low compliance costs. Our alternative scenario could deliver a higher biodiversity impact in terms of area with goal oriented measures but also leads to higher on-farm costs. Nevertheless, compliance costs are also in this scenario far below the current payment level.

Keywords: Greening, biodiversity decline, bio-economic modelling

1 Introduction

The Global Biodiversity Outlook 4 states that the loss, degradation and fragmentation of habitats continue dramatically worldwide (SCBD, 2014). Ending biodiversity loss is therefore a global task as stated by the UN sustainable development goals¹ (UNDP, 2016). For example, wild birds show a decline of 20% since 1980 in North America and Europe (SCBD, 2014, p.51). The midterm report of the EU states that 70% of species in the EU are threatened by habitat loss (EC, 2015, p.4).

Given these pressures on biodiversity and natural resources more generally, the 2013 reform introduced 'Greening' as a new component of the Common Agricultural Policy (CAP)². 30% of the national direct payments budgets are now paid as green direct payments coupled to the fulfilment of three actions: 1) crop diversification, 2) maintaining permanent grassland, and 3) dedicating 5% of arable land to 'ecologically beneficial elements' ('Ecological Focus Areas', EFA). The EFA-requirement can be fulfilled through different land use options with different weight factors (WF): landscape elements (WF: 1-2); cultivation of legumes, fallow land and buffer strips (WF: 0.7-1.5); and cultivation of catch crops and cover crops, and agroforestry (WF: 0.3) (BMEL, 2015).

The effectiveness of the EFA has been questioned by scientists and practitioners since (Lakner et al., 2013; Isermeyer et al., 2014; Kirschke et al., 2014; BfN, 2015). Isermeyer et al. (2014), for example, argue that Greening will be a very expensive instrument with only marginal positive effects for biodiversity as the 2005 enforced cross compliance requirements already included crop diversification and the prohibition of permanent grassland conversion, thus no additional benefits from these two actions can be expected, leaving the 5% EFA requirement as the only new condition. Isermeyer et al. argue that if one would relate the new

¹ <https://sustainabledevelopment.un.org/?menu=1300>

² Regulation (EU) No 1307/2013; <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R1307&from=DE>

green direct payment (85 Euro³ in Germany for the entire land of a farm) only to the small EFA area, extremely high payment rates of 1.700 Euro/ha would result that were better used for more effective 2nd pillar measures (Isermeyer et al., 2014). Other authors argue that the Greening rules may affect farms quite differently depending on their specialisation, e.g. specialised livestock farms may not be affected much by the Greening rules (Lakner et al., 2013, p.19ff), raising fairness concerns.

Taking up these arguments, the objective of this article is to analyse and compare the Greening rules currently implemented in Germany as well as expert-based alternative Greening rules with a potentially higher biodiversity benefit with regard to effects on agricultural income and production pattern in different German regions and farm types. The purpose of this comparative analysis is to provide insights regarding the effectiveness of Greening and to identify possible alternatives.

2 Material and methods

2.1 Case study regions

Three NUTS3 administrative regions located in a west to east transect in Northern Germany were selected for this analysis: Diepholz and Uelzen are situated in the western German state Lower Saxony, and Oder-Spree in the eastern state Brandenburg. As shown in Table 1, Diepholz has the most favourable site conditions for agricultural production of the three regions, followed by Uelzen, while Oder-Spree is dominated by sandy soils. Diepholz has the largest number of farms and the regional production focus lies on arable and pig farming, whereas Uelzen is clearly dominated by cereal farming, often specialised in root crops. Oder-Spree is dominated by arable farms, followed by dairy farms (NaLaMa-nT, 2013). The average farm size in Oder-Spree is with 256 ha more than twice (Uelzen) and three times (Diepholz) higher than in the two western regions (Table 1).

Table 1 Characteristics of the case study regions

	Diepholz	Uelzen	Oder-Spree
Federal State	Lower Saxony	Lower Saxony	Brandenburg
Total agricultural area of region [ha] ^c	160,636	93,949	88,307
Farms [n] ^c	2419	823	323
Average farm size [ha] ^c	73	99	256
Average livestock density region [LSU/ha] ^c	1.27	0.60	0.55
Farms by type [n]: arable/ dairy/suckler/ pig ^d	580/ 333/ 42/ 416	405/ 34/ 0/ 54	60/ 22/ 3/ 1
Ecological Focus Area (EFA) 2015 [ha]	18,616	8,178	113,340*
% of EFA area used for intercropping ^e	76.5	61.4	48.0
% of EFA area used for legumes ^e	0	2.5	19.0
% of EFA other ^e	23.5	36.1	33.0
% set-aside area in total arable area 2014/ 2015	1.30/ 1.32 ^a	1.30/ 1.32 ^a	3.7 /4.3 ^b
Average precipitation per year [mm] ^f	786	628	541

^a DAHL (2015) data for Lower Saxony, ^b data for Brandenburg as a whole (Destatis, 2015), ^c NaLaMa-nT (2013): IACS data 2010, ^d according to own classification of IACS data, ^e Deutscher Bundestag (2015),

^f <http://de.climate-data.org/location/47524/> (2016-08-02)

³ Status at the time of this publication, in 2015 the national value of the greening payment was set at 87 Euro/ha

2.2 Scenarios

To analyse the potential of the current Greening regulation in comparison to alternative options we compared four scenarios: a reference scenario representing the 2003 CAP reform ('Decoupling', REF), one representing the 2013 CAP reform with the newly introduced basic, redistribute and greening payments (EFA) and an alternative scenario with alternative biodiversity enhancing measures replacing the ecological focus area of the EFA scenario (BDIV, see Table 2). In order to derive the on-farm compliance costs of fulfilment of the Greening rules, an additional scenario with only basic and redistributive payment but excluding the greening payment (BAS) was run. Compliance costs of provision of the ecological focus area (scenario EFA) as well as for the provision of areas with specific biodiversity activities (scenario BDIV) are then calculated as the income difference of these scenarios compared to the BAS scenario. The current CAP greening rules are based on continued basic area payments and additional payments for ecologic focus areas. Farms with more than 15 ha are allowed to combine set-aside areas with intercrops and pure legume crops. If the Greening rules are met, farms receive in addition to the basic payment of 190 €/ha in Diepholz and Uelzen and 160 €/ha in Oder-Spree an additional payment of 87 €/ha. Farms with less than 15 ha receive the Greening payment without additional obligations. The Greening rules essentially imply the ecological focus area which can be achieved through growing intercrops (counting for 30%), legumes (counting for 70%) and set aside or landscape elements (counting for 100% of the area).

Table 2 Overview of the simulated scenarios – all scenarios assume prices of 2014

Acr.	Scenario description	Payment structure [Euro/ha]	Diepholz / Uelzen	Oder- Spree
REF	CAP 2003: Decoupling	Single area payment	304	300
BAS	CAP 2013 without Greening: Basic and redistributive payment; to calculate the compliance costs in EFA and BDIV	Basic area payment ^a Redistributive payment ^b	190 50/30	160 50/30
EFA	CAP 2013 including Greening rules: (landscape elements are not considered)	Basic payment ^a Redistributive payment ^b Greening payment	190 50/30 87	160 50/30 87
BDIV	CAP 2013 - Greening replaced by 5% of arable land taken out of production and used for biodiversity enhancing measures	Basic payment ^a Redistributive payment ^b Biodiversity payment	190 50/30 87	160 50/30 87

^a for the whole agricultural land, ^b 50 € for the first 30, and 30 € for the following 16 ha

In the alternative scenario (BDIV), 5% of the cropland is dedicated to specific biodiversity conservation practices. The threshold of 5% was used to allow for comparison with the EFA scenario. The practices are taken from a practitioner's guide for the creation of 'nature fallows' (*Naturbrachen*) published in 2011 (Berger and Pfeffer, 2011). Berger and Pfeffer (2011) suggest a mix of different measures on set aside land with natural and sown flora combined with tillage, cuts at different times and partly removal of biomass. Field margins or especially dry/ humid parts with reduced yields would offer high potential for local species while their abandonment reduces workload for the farmer without high gross margin impacts (Berger and Pfeffer, 2011, p.23-24; Miettinen et al., 2012, p.125; Field et al., 2015, p.15). For the scenario BDIV, it is assumed that 5% of the arable land is managed according to Berger & Pfeffer. Table 3 shows how this area is then managed by different regimes according to the type of soils. Thus flower rich buffer strips are established, partly based on natural vegetation and partly on sown mixtures of herbs. These measures are established for half of the set aside area on soils with a lower soil quality, while the other half is evenly distributed over soil classes with higher production potential (Berger, 2015). All CAP payments in the EFA scenario were sustained at the same level as in the EFA scenario.

Table 3 Types of biodiversity management and their area share.

Management types	Sandy soils	All other soils
Natural Vegetation, cut with removal in spring and autumn	29.2%	27.8%
Natural Vegetation, no cut	12.5%	
Seeding after tillage, cut with removal in June	12.5%	
Natural vegetation, with a cut in June and light tillage after	29.2%	22.2%
Tillage, Seeding in spring and cut in June	16.7%	
Tillage, Seeding in spring		38.9%
Tillage every third year and high cut in June		11.1%
<i>up to 50% on marginal sandy soils – if available, rest on other soils</i>	100%	100%

These measures are designed to address biodiversity declines – the explicit justification for the Greening payments. They create areas with no applications of plant protection products, a large diversity of flowering plants spread over the vegetation period because of the diversity of measures and timing and a more sparsely vegetation structure.

2.3 Farm economic modelling approach

To simulate farmers decision behaviour in the different scenarios, the bio-economic whole farm model MODAM (Multi Objective Decision support tool for Agroecosystem Management, see Zander and Kächele, 1999) was used. MODAM is based on three components: (i) a database system describing regional varieties of production alternatives for agricultural crops, fodder, livestock and biogas production; (ii) an economic and ecological evaluation of the production alternatives; and (iii) a comparative-static, mathematical programming module. MODAM has been used in several studies to assess the impact of agricultural management options on different environmental indicators (e.g. Schuler and Kächele, 2003; Sattler et al., 2006; Schuler and Sattler, 2010; Uthes et al., 2010; Schuler et al., 2013).

The model takes a number of farm internal interactions into account: (i) crop rotational restrictions, (ii) feed production for livestock and (iii) substrate production for biogas plants and (iv) usage of organic manure and fermentation residues (digestate) from bioenergy plants within crop production. The model guarantees that total fertilization based on organic manures and mineral fertilizers meet the demand of crops. In agreement with the fertilizer regulation, the model allows that nitrogen fertilization is up to 60 kg of N/ha in excess of crop requirements.

The model assumes the farmer to act as a *homo oeconomicus*. Nevertheless we are aware that individual decision-making behaviour of farmers also depends on other factors, such as personal, business-related or location-specific conditions that are not considered.

The scenario runs are run for 46 typical farms (representing 1371 farms) respectively 15 (493) in Uelzen and 25 (86) in Oder-Spree. Land market activities are not taken into account, and no additional calibration procedure was used. However, model outputs are routinely benchmarked through comparison with available empirical data to ensure that model output and actual land use go along.

Farm typology

Data from the Integrated Administration and Control System (IACS) and the Land Parcel Identification System (LPIS) of the year 2010 were used to develop a farm typology for each region. The typology is based on farm types (arable,

Table 4: Farms and farm types per region [n]

Case study region	Farms	Farm types
Diepholz	1,371	46
Uelzen	493	15
Oder-Spree	86	25
Sum	1,959	86

dairy, mixed and pig farms) and four size classes for total land (farms below 10 ha were not considered) and livestock numbers (four classes for each: dairy cows, sows, pig fattening, fattening bulls; and three classes for suckler cows).

The combination of farm size and livestock classes resulted in a total number of $4*4*4*4*4*3 = 3,072$ theoretically possible combinations across all regions. However, not all combinations occurred in each region, reducing the number of farm types to be modelled. To even further reduce the modelling effort, we additionally defined that the final farm types should represent 80% of the total regional agricultural area, resulting in a final number of 86 farm types (Table 4). Diepholz stands out with a high number of farms and farm types due to the high diversity of livestock enterprises in this region.

Production activities and prices

Important input to the farm model are production activities that provide the relevant production options to optimise resource allocation for a maximum total gross margin. Crop and grassland production activities were derived from expert based description of management combined with statistical, soil type specific yield data (MIL, 2010; LWK, 2013; Hufnagel, 2014). Machinery costs were calculated from KTBL data (KTBL, 2010), while input and product prices were based on average data from 2010 to 2013 (sources: MIO 2010-2013 for Brandenburg; LWK 2013 for Lower Saxony; BLE (2015)). Livestock activities were defined on the basis of KTBL data thereby using different performance levels for different size classes (KTBL, 2015).

2.4 Output generation and biodiversity performance

To obtain regional land use indicators the results of the individual farm models were aggregated through multiplication with the number of farms represented and subsequent summation over the region.

There are different ways to show the ecological impact of the different scenarios. We assume that the biodiversity oriented measures lead per default to higher ecological impacts compared to crops or even simple set-aside. As a complex biodiversity measure is not yet available, we used the Shannon crop diversity index (SHDI), also known as Shannon-Wiener index. Despite several limitations, it is widely used to quantify richness and spread of cultivated crops (Mittenzwei et al. (2007); Piorr (2003); Mahy et al. (2015)). It usually ranges between 1.5 and 3.5 (Mittenzwei et al. (2007)). We calculated the indicators along scenarios and for different farm types in all three regions.

3 Results

3.1 Production pattern

According to our modelling results the introduction of the Greening rules (EFA) has only small effects on the production pattern compared to the REF scenario in all three regions. Cereals slightly decrease and a small proportion of 0.7 - 2.3% set aside land with mulching is created. In the BDIV scenario, as defined in the model, 5% of the farm area is dedicated to biodiversity enhancing measures, also mostly through a reduction of cereals.

A comparison of the REF and EFA scenario reveals how the model farms adapt to the 2013 CAP reform. In Diepholz, 62% of the farms (n=849) show differences between the REF and EFA scenario (**Error! Reference source not found.**). Changes occur in arable, suckler cow and pig farms, while dairy/mixed farms remain unaffected (not shown). Uelzen has a higher share of farms with changes (71.2 %, n=351), yet only one farm type is affected (arable farms). In Oder-Spree almost 90% of the farms (n=77) react with some changes in their production pattern, of the arable and suckler cow farm type all farms are affected. In 47 farms (54.7%) belonging to these two farm types changes affect more than 30% of the total farm

area. The production pattern of farms without changes between REF and EFA scenario contained already components qualifying as EFA in the REF scenario. Unaffected farms in Diepholz had on average 10.6% EFA in the REF scenario (Figure 1), in Uelzen 7.8% and in Oder-Spree 5.9%. Thus, these farms clearly fulfilled the Greening rules for the EFA already in the REF scenario.

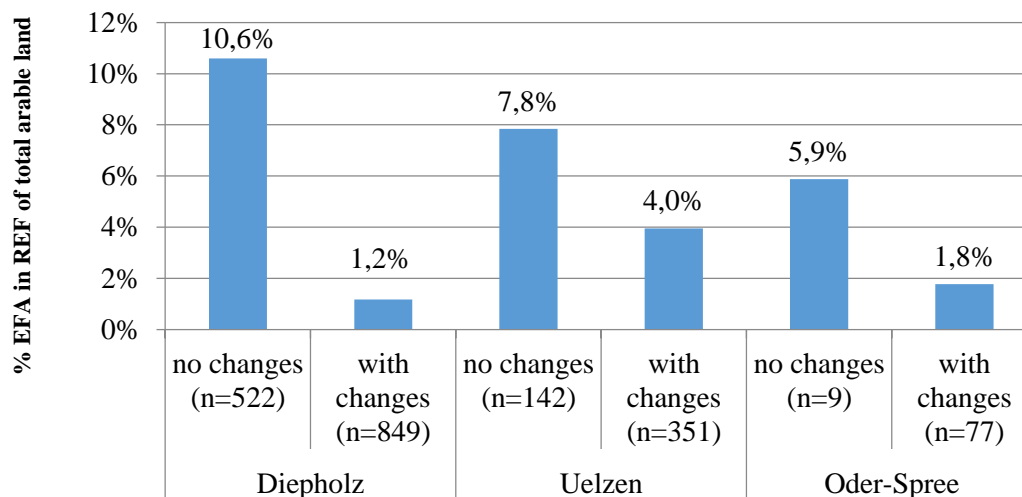


Figure 1 Hypothetical EFA area in the REF scenario of farms with and without production changes in the EFA scenario

Farms without changes in the production pattern from REF to EFA had on average a higher share of catch crops in the REF scenario (Diepholz: 45.7%, Uelzen: 44.7% of the total farm land of these farms) compared to those with changes (on average 7.7% catch crops in total farm land in Oder-Spree, 15.1% in Diepholz und 29.9 % in Uelzen). Additionally, farms without changes had also a lower share of root crops (Diepholz: 24.4%) farms with changes: 39.2%; Uelzen: 54.1%/ 61.1% root crops; Oder-Spree: 19.4%/ 24.8%).

The BDIV scenario requires by its set up an adaptation of the crop production in all farms. **Error! Reference source not found.** shows for the REF scenario the total land per crop and the changes in land use for EFA and BDIV only as difference with the REF scenario.

Table 5 Shannon index of changing crop diversity along scenarios in absolute scores and percentage changes in relation to the pre-Greening policy

Region	arable	%change to REF	dairy	%change to REF	mixed	%change to REF	pig	%change to REF
Diepholz								
REF	2.025		1.456		1.841		1.994	
EFA	2.047	1%	1.456	0%	1.779	-3%	2.022	1%
BDIV	2.112	4%	1.527	5%	1.926	5%	2.070	4%
Uelzen								
REF	1.911		1.897		1.889		1.862	
EFA	1.946	2%	1.897	0%	1.889	0%	1.862	0%
BDIV	2.012	5%	1.994	5%	2.003	6%	1.940	4%
Oder-Spree								
REF	1.567		1.641		1.607			
EFA	1.623	4%	1.674	2%	1.655	3%		
BDIV	1.635	4%	1.745	6%	1.678	4%		

The cropping pattern is much more affected in BDIV than in EFA. Cereals are reduced in all regions, while the most profitable root crops: sugar beets and potatoes are not affected at all.

Relative to the area in the REF scenario, winter rye as a typical crop for marginal soils shows the highest changes. Set aside as the most relevant change concerning biodiversity in the EFA scenario reaches only 1.4%, 0.7% and 2.3% in Diepholz, Uelzen and Oder-Spree, respectively. The scores of the Shannon index differ along regions and farm types and do not reveal a dominant pattern at first sight. However, the scores for the BDIV scenario are the highest for every region and farm type. Arable and pig farms reach the highest scores in Diepholz, followed by arable and mixed farms in Uelzen. Other farms do not reach the score of 2. Thus, dairy farms in Diepholz have the lowest scores without any changes with the current greening policy, starting with 1.456. Oder-Spree's farms follow with especially low scores for arable and mixed farms that do not increase substantially along the EFA/ BDIV scenarios. In Uelzen, current greening policy would not change crop diversity for dairy, mixed and pig farms.

3.2 On-farm compliance costs

On-farm compliance costs reflect the income forgone resulting from the adaptation of the model to changed framework conditions. The calculated compliance costs are the value that is necessary to compensate losses. This value is only an indication of the minimum payment level required by farm type.

Table 6 shows the compliance costs for implementation of the greening rules in the EFA scenario. In general compliance costs are relatively low. Highest costs occur in arable and pig producing farms in Diepholz followed by arable farms in Uelzen, while arable farms in Oder-Spree had the lowest costs, as poorer soil conditions limit the costs of setting area aside. Some farm types in Uelzen have zero compliance costs as there irrigation based potato and sugar beet focused production systems are managed with a high share of intercrops. In Diepholz the higher level of livestock and biogas plants causes higher compliance costs.

Table 6 Compliance costs [EURO/ha_{EFA}] for implementation of an ecological focus area on (weighted) 5% of the farm land

Region	arable	mixed*	suckler	pig	Area weighted average
Diepholz	201	0	72	182	135
Uelzen	50	0	0	0	40
Oder-Spree	31	26	18		27

* Mixed farms include dairy farms

Compliance costs in the biodiversity scenario are related to the area of farm land covered by biodiversity enhancing measures (ha_{Bio}). Contrary to the ecological focus area here farms are forced to take 5% of their arable land out of production for biodiversity measures. Reflecting differences in site conditions and production orientation (as shown in Table 1), the on-farm compliance costs of the farm types for practicing biodiversity enhancing measures are lowest in Oder-Spree (regional mean: 216 EURO/ha_{Bio}, Table 7) and highest in the livestock dominated Diepholz (679 EURO/ha_{Bio}), while Uelzen (461 EURO/ha_{Bio}) is in the middle between the two extremes. The rate per ha_{Bio} is still far below the current greening payment of 1,700 EURO/ha (if only related to the 5% EFA area, see argumentation from Isermeyer et al. in the introduction). Thus, the proposed biodiversity enhancing measures would be achieved at lower public per ha costs compared to the current EFA area. Regarding the different farm types, there is no consistent pattern across regions (Table 7). Oder-Spree shows the lowest compliance costs in arable and suckler farms. In Uelzen, arable and pig farms are affected most, while in Diepholz suckler and mixed farms would have the highest compliance costs.

3.3 Agricultural income

As indicator for agricultural income the net value added at factor cost (including public payments) divided by the calculated total workforce for production and management of the

simulated farm types was analysed. As the scenario BDIV was defined with the same CAP payments as the EFA scenario, payments are sustained at the same level. Therefore income effects result only from variable costs of the biodiversity measures and from forgone agricultural production on the biodiversity area. The introduction of Greening (scenario EFA) leads only in Oder-Spree (Brandenburg) to a slight reduction of the total CAP payment per work force compared to the situation before ‘Greening’ (REF). The BDIV scenario has as defined the same total payments as the EFA scenario.

Table 7: Compliance costs [EURO/ha_{Bio}] for implementation of biodiversity enhancing measures on 5% of the farm land

Region	arable	mixed*	suckler	pig	Area weighted average
Diepholz	679	722	850	615	679
Uelzen	433	437	423	644	461
Oder-Spree	148	271	142		216

*Mixed farms include here dairy farms

The total agricultural income per workforce ranges from 19 and 154 T€ where dairy and mixed farms show the lowest income level in all regions and scenarios. The highest income per workforce in all regions is achieved in arable farms with biogas plants with the highest level in Diepholz. The income reduction in Oder-Spree from REF to EFA is in the first place due to the reduced CAP payments. The income excluding CAP payments is practically the same in both scenarios and shows in Oder-Spree a high negative value for suckler cows that is however more than compensated by public payments.

Table 8: Economic impact of scenarios on agricultural income [EURO/workforce], [EURO/ha UAA], payment levels [EURO/workforce]

	Diepholz			Uelzen				Oder-Spree			
	arable	mixed**	suckler	Pig	arable	mixed**	suckler	pig	arable	mixed**	suckler
Total Income per calculated work force (production plus management)											
REF	152,737	19,724	37,393	41,333	135,900	23,842	77,633	82,637	121,679	35,544	80,094
EFA/REF	101%	99%	100%	98%	99%	99%	99%	99%	89%	88%	78%
BDIV/EFA	97%	96%	96%	97%	100%	98%	100%	100%	98%	97%	97%
Income per calculated work force excluding CAP payments											
REF	112,619	12,857	22,096	25,997	103,528	15,096	52,363	67,598	25,206	10,557	-36,572
EFA/REF	101%	100%	99%	99%	100%	100%	100%	100%	102%	100%	101%
BDIV/EFA	97%	94%	94%	95%	100%	97%	99%	99%	89%	89%	106%

The average loss in agricultural income per workforce in the BDIV scenario compared to the EFA scenario ranges from 85€ (Uelzen) to 4030€ (Diepholz) per workforce due to the forgone agricultural income on the biodiversity areas. This is due to the high payment level in the EFA scenario – and not as in the previous section a result of high compliance costs per ha. Livestock units remain unchanged in all scenarios. Finally, losses in the market-based income (excluding payments) are relatively moderate in most cases, ranging between -11% and +6% compared to the EFA scenario. Highest losses occur in Oder-Spree followed by Diepholz and the lowest losses in Uelzen with 1 to 3%. Differences between the regions are partly explained by the lower per ha productivity in Oder-Spree but at the same time larger sized farms. As the per-ha-workforce is also lower, the lower per ha income is outweighed in the farm income per workforce measurement.

3.4 Discussion

In this study changing production patterns, compliance costs and related income losses in the analysed scenarios illustrated differences between the EU Greening policy and alternative biodiversity measures. The model output shows that the EFA scenario requires only little adaptation in the cropping pattern and compliance costs are low. One third of all farms showed no adaptation to the Greening rules within the EFA scenario at all. As semi-natural farm land was not considered, neglecting that farms can claim these areas also as EFA, the changes required to adapt to the Greening rules are likely to be even lower than the already low rates in the model.

Preliminary data on the implementation of the current CAP reforms confirm the effect, reporting that 40% of farms in the EU had to modify their production patterns in order to comply with Greening rules. More precisely, only 21% of arable land was affected by crop diversification (Lakner, 2016). An Italian study modelling Greening for a region in Southern Italy noticed contradictory effects of the new CAP program applying only for some farms, since a large number of local farms are below the threshold in land size and others could possibly opt-out preferring a lower rate of CAP payments over income losses due to reduced production. They expect especially biogas producers and dairy farms perceiving a high level of maize production more profitable than subsidized diversification (Cortignani et al, 2015). In our study, farms with biogas plants or livestock face also higher compliance costs than other farm types, but CAP payments are even in the biodiversity scenario with more demanding measures high enough to compensate income losses.

Similar to Miettinen et al. (2012) we proposed to at least partly arrange the biodiversity areas along field borders – preferably along forest borders – here costs would be lower and at the same time a higher biodiversity impact is expected. The compliance costs of the biodiversity measures range between 150 and 850 €/ha which is still far below the 1740 €/ha that are paid as Greening payment (related only to the EFA area). Thus, with the same level of public costs, farmers' introduced highly efficient biodiversity measures but also experienced higher compliance costs. As indicated above, compliance costs differ considerably between regions and farm types reflecting the productivity of the agricultural land in relation to its agro-environmental conditions and the production orientation. Therefore, a regional level implementation of EFA, as offered by the European Commission, is seen as a necessary element in the implementation process (Westhoek et al, 2012, p.3). However, neither Germany nor any other Member State opted for this possibility (EC, 2015a, p.12).

When analysing the different effects on biodiversity along our scenarios, a simple indicator of biodiversity is given by the Shannon index of crop diversity. Even though the effects differ along scenarios, farm types and regions, one pattern can be seen clearly: The strictest scenario BDIV increases crop variety the most with 4% to 6% additional percentage points compared to the reference scenario, where the higher species richness within the EFA area is not even considered. In absolute figures, Diepholz has the biggest and most evenly spread crop variety of all regions when looking at arable and pig farms, whereas Oder-Spree does not reach 1.8 points in any farm type. This coincides with farm sizes, where Diepholz is characterised by a large number of smaller farms, while Oder-Spree has fewer and larger farms with a focus on cereal production. The low impact of the EFA scenario is also reflected in the number of farms without changes in cropping structure in our model. The Diepholz region has the highest share of farms without any changes from the REF to the EFA scenario due to a higher share of catch crops which enlarges the spread in diversity. However, all scores together are rather low with a range from 1.5 to 2.1, when we consider the usual SHDI lying between 1.5 and 3.5 (Mittenzwei et al., 2007). Possibly scores would raise strongly in the BDIV scenario, if we would take the different schemes applied within the biodiversity management into account.

At this stage, a more comprehensive assessment of the biodiversity impact of our scenarios is not possible. However, the impacts of similar measures found in literature confirm that the designed measures would have a considerable positive impact on biodiversity. Dicks et al. (2014) collected evidence from numerous studies that support the Berger & Pfeffer approach. Practical evidence from a farm in the UK show a 170% increase in farmland bird index within 13 years by taking 10% of the field out of production, while other measures, such as cultivation of legumes were far less successful (Field et al., 2015, p.14). Batáry et al. (2015) identified in a regression analysis that so-called ‘out-of-production schemes’, similar to those proposed by Berger and Pfeffer (2011), are much more effective in terms of biodiversity effects compared to ‘in-production schemes’ where only the agricultural management intensity is reduced (Kleijn et al., 2011; Batáry et al., 2015). Further, only targeted measures are able to address specific needs in terms of resources or space of species that are rare (Batáry et al., 2015, p.1011). In other words, in-production measures, such as intercropping or catch crops support species communities, which are already adapted to intensively used fields, but are usually not those who are endangered (Tscharntke et al., 2011; Batáry et al., 2015). Our study is less explicit in relation to the impact on greenhouse gases, but shows that higher levels of areas managed for biodiversity increase can be achieved at the same public costs level as the current CAP with significantly increased crop diversity.

So far, there is no study in Germany showing the transitional income effects of different conservation schemes in relation to payment levels and land use effects. Thus, our study fills a gap in picturing clearly conditions under which biodiversity targets in farmland conservation can be attained.

4 Conclusions

With the current CAP many farms have low or no compliance costs. The ecological focus area has only little impact in terms of area affected by land use changes and quality of the land use due to high windfall effects, which we even underestimated in our study as we did not take into account that many farms can declare semi-natural habitats within their farm area as ecological focus area. A higher ecological impact could be achieved at the same level of public costs if the greening payment was used to finance more targeted biodiversity enhancing measures. Therefore, biodiversity could be served much better than the current CAP regulations do. Maintaining the current basic and greening payments in scenario BDIV allowed higher biodiversity impact along with minor income losses. However public costs are still relatively high compared to the compliance costs farmers have. Above in our biodiversity oriented scenario, compliance costs were higher but – relative to the area productivity – also more evenly distributed as all farmers had to reduce their productive area with the same share.

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