Impacts of rural development programmes in Germany on the reduction of greenhouse gas and ammonia emissions and associated mitigation costs

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Abstract

The European Union's (EU) rural development (RD) policy as part of Common Agricultural Policy (CAP) is considered to be a central instrument to reduce greenhouse gas (GHG) and ammonia emissions from agriculture. We present impacts on and mitigation costs of the reduction of GHG and ammonia emission induced by four German RD programmes 2014 to 2022 for the period 2015-2018/2019. Emission reduction has been of little importance in the RD programmes studied: One third of RD expenditures had climate relevant (side) effects, but only 3 % of RD expenditures were targeted to climate mitigation. RD programme support reduced total GHG in the study regions by 0.1 %, GHG emission in the agricultural sector by 1.4 % and ammonia emission from agriculture by 0.9 %. Compared to set reduction targets, the impacts are rather small. About 90 % of reduced GHG emissions and 25 % of reduced ammonia stem from input-reducing measures as organic farming and other agri-environmental and climate measures (AECM). These emission reductions are likely to be offset by displacement effects elsewhere and have a risk to be reversed. Mainly permanent, non-reversable emission reductions arise from investments and AECMs supporting emission reduced slurry systems, advisory support targeted to water protection as well as from investments into forests and peatland restoration. Estimated mitigation costs include public implementation costs and are lowest for standard RD measures with high uptake rates as e. g. for organic farming. To increase the impacts of RD programmes, more effective measures specifically targeted to permanent and non-reversable emission reduction, are required.

Keywords

impact evaluation, CAP, RD programmes, second pillar, agricultural policy, climate mitigation, green house gas emissions, ammonia emission, Germany, impacts, mitigation costs

Introduction

Climate protection has become one of the top political issues in recent years. Since 2019, climate targets of the EU (EU-KOM, 2020) and Germany (BMU, 2019) were significantly enforced and sector targets were set. The European Union's RD policy as part of the CAP is expected to significantly contribute to the climate targets for agriculture. However, the empirical evidence of CAP impacts on emission reduction is patchy. The European Court of Auditors (2021, p.3) concludes for the period 2014-2022, that "… €100 billion of CAP funds attributed during 2014-2020 to climate action had little impact on agricultural emissions, which have not changed significantly since 2010." An EU-wide impact analysis partly supports this view: Quantifiable CAP-impacts reduced agricultural GHG emissions by 4.6 %, compared to a situation without a CAP. Pillar I contributed most to this reduction (3.5 %), while the RD programmes of Pillar II accounted for a reduction of just 1.1 %. Due to methodological caveats, these figures are to be treated with caution (Alliance Environnement, 2018). Nevertheless, both publications suggest low CAP impacts on the reduction of GHG emission.

This notion complies with our findings from the impact evaluation of four RD programmes in Germany. The evaluation of RD programmes is mandatory and usually performed twice per programming period. For the current RD programmes 2014-2022 the mid-term evaluation was accomplished in 2018 and the ex-post evaluation results will be available in 2026. A synthesis report summarising mid-term findings of about 120 RD programmes of Member States is available from the European Evaluation Helpdesk for Rural Development (ENRD, 2019). For Germany, a detailed analysis of RD programme 2014-2022 impacts on emission reduction is missing, since each of the thirteen German RD programmes is evaluated separately. For purely nationally financed measures with a climate focus, impact evaluations are not available at all.

In this paper, we estimate impacts of RD programmes on the reduction of GHG and ammonia emissions for the period 2015-2018/2019. RD programmes 2014-2022 studied include those of the four German federal states of Lower Saxony/Hanseatic City of Bremen (LS), Schleswig-Holstein (SH), Hesse (HE) and North Rhine-Westphalia (NRW). Impacts are estimated for all RD programmes and for individual RD measures, including organic farming (M11), various AECM schemes (M10), investment support (M4) and advisory services (M2). Mitigation costs of selected RD measures are analysed for the RD programmes 2007-2013. The results presented here are published in the annual implementation reports 2019 of the RD programmes (HMUKLV, 2019; MKULNV, 2019; Grajewski et al., 2019; Raue et al., 2019) as well as in the thematic evaluation reports available from our project homepage (TI-LR, 2022). This is the first time that climate impacts of Pillar II RD programmes in Germany are considered across federal states.

RD policy in Germany and study regions

The four study regions are situated in the north-western part of Germany. Together, they account for 35 % of the utilised agricultural area of Germany. With the exemption of mid-range mountain areas in Hesse, south of Lower Saxony and in North Rhine-Westphalia, the study regions are among the most favourable for agricultural production in Germany (see Figure 1).

Public expenditures (EU and national funds) for RD programmes in Germany were € 5.4 billion between 2015 and 2018, of which one third (€ 2.0 billion) was allocated to the study regions. Figure 2 displays expenditures to climate relevant RD measures. These are measures that are either targeted to climate mitigation and adaptation or measures with climate impacts without being targeted to that objective. Measures targeted to climate mitigation (including ammonia emissions) are specifically designed to primarily deliver relevant impacts. RD expenditures targeted to climate mitigation sum up to 5 % (Germany) and 3 % (study regions) of total expenditures, only. Respective measures include AECM (M10) like varied crop rotation and emission reduced slurry management, investments into slurry management (M04) and forestry measures (M08). Expenditures for climate adaptation, such as investments into coastal and flood prevention (M05), are of high importance for the coastal states of Lower Saxony and Schleswig-Holstein. About 42 % (Germany) and 27 % (study regions) of RD expenditures had no programmed target on climate mitigation but relevant impacts. This applies to most AECM (M10) and organic farming (M11), both primarily designed for the purpose of biodiversity, water and soil protection.

Figure 1: Study regions in Germany

Source: ©Thuenen-Institute

Figure 2: Public expenditures (EU + national) for climate relevant measures in Germany and in the study regions, as a share of total RD expenditures 2015-2018 (without technical assistance)

Source: EU-KOM (2019) , monitoring data 2015 to 2018 of the states, own estimation.

These figures imply that climate mitigation has been of low importance in RD programmes in Germany and in the study regions, so far. Most climate relevant impacts originated from measures not targeted to climate mitigation. Their impacts are rather welcoming side effects. Compared to the RD programmes 2007-2013, the focus of RD expenditures 2014-2022 shifted from the agricultural sector to resource protection (Tietz, 2007), while the importance of climate mitigation remained low.

In our analysis we consider all interventions targeted to climate mitigation as well as interventions without such a target but with expected impacts. We do not consider interventions for climate adaptation (e. g. flood prevention) nor purely nationally financed support schemes with a similar focus.

Methods and data

The methodological framework for impact evaluations of RD programmes is set by the Common Monitoring and Evaluation Framework (CMEF). It defines impact indicators (see table 1) and methods to be used (EU-KOM, 2014, 2018). The CMEF methods are compatible to those used in the national GHG inventory (Haenel et al., 2020) . An impact is defined as the difference between the observed situation with support and the potential situation without support.

Table 1: CMEF impact indicator GHG emissions from agriculture (I.07)

Subindicators		**Unit of measurement**
I.07.1a	GHG emissions agricultural sector	tones of CO_2 equivalents (t CO_{2eq})*
I.07.1b	GHG emissions LULUCF sector	tones of CO_2 equivalents (t CO_{2eq})*
I.07.2	Ammonia emissions from agriculture	kilotons of ammonia emission (kt NH_3)

* Note: For reasons of practicability, GHG are measured in kt of CO_{2eq} throughout this paper.

Source: EU-KOM (2018)

Impacts are estimated for those measures and projects for which the payment was made between 2015 and 2018 (GHG) or 2019 (ammonia emissions), respectively. The extent, type and location of the supported measures and projects are analysed on the basis of various data sources:

- Monitoring data contain output and results indicators, e. g. the number of projects and hectares supported under a certain measure. The indicators are aggregated per RD programme and RD measure (e. g. M04) and provide an overview of programme implementation. The content and structure of monitoring data is defined at EU-level.
- Measure-specific data provide information for each RD measure on the individual project level, e. g. financial indicators, project and beneficary characteristics as well as the start and the finish of the project. The data structure and content vary between measures and programmes.

- IACS data are used to analyse area-based RD measures as organic farming and AECM. IACS includes farm- and area-specific information on Pillar I and II support. Information on land use, the geo-referenced location of supported land plots and of the applicant's farmhouse are used.
- The impact of organic farming and ACEM on nitrogene input is estimated upon nutrient comparissons according to the German Fertiliser Regulation. The data contain non-randomly sampled farms with and without RD paraticipation.

The impact of RD measures on fertiliser use is crucial to estimate their climate mitigation impacts. As a standard approach, impacts on nitrogen input and nitrogen balance are estimated based on literature (z. B. Osterburg und Runge, 2007). For North Rhine-Westphalia and Lower Saxony, these estimates were enhanced by applying a counterfactual study design according to Heckman et al. (1998). We used matching techniques to estimate the impact of participation to AECM (low-intensive grassland management, nature conservation grassland management, intercrops, varied crop rotation) and organic farming (see Roggendorf und Schwarze, 2020). Underlying data comprise IACS data and nutrient comparison data according to the German Fertiliser Regulation (DüV-20). The analysed data sample for North Rhine-Westphalia comprised records from 3015 farms, of which 993 participated to AECM or organic farming. 2022 farms did not participate in any scheme and were used as potential controls.

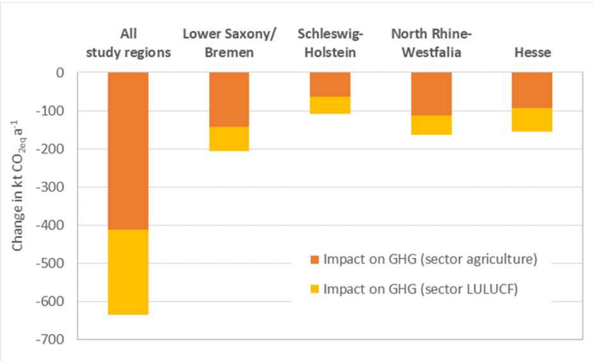
Mitigation costs, that are the costs of reducing one tone of carbon dioxide equivalent, are estimated for RD programmes 2007-2013. The cost side comprises public funds spent on average from 2010 to 2012 as well as the public costs of administrative implementation in the reference year 2011, the so-called implementation costs. The workloads for implementing RD measures and for the programme overhead in the managing authority were collected by using a questionnaire-based census. The workload in full-time equivalents was converted into costs using personnel cost tables of the federal states. Material costs, e. g. for applying information technologies, were added. As far as information from the cost and activity accounting was available, it was used for plausibility checks. Further information on the methodology are available from Fährmann and Grajewski (2013).

Empirical results

A total of 636 kt carbon dioxide equivalents (CO_{2eq}) were reduced through RD support between 2015 and 2018, as compared to the situation without support. 64 % of these emissions (411 kt CO_{2eq}) stem from the agricultural sector, the remaining part from the LULUCF sector. The impact is equal to a 0.1% reduction of total GHG and a 1.4 % reduction of GHG emissions in the sector agriculture. The impacts for the agricultural sector varies between -1.0 % in Lower Saxony and -3.6 % in Hesse, depending on the type and extend of RD measures adopted (see figure 3a). Compared to the national reduction target for the agricultural sector of 20 % until 2030 (Federal law on climate protection), the estimated impact of 1.4 % is low. The impact is even lower (-0.4 %), if only "additional" impacts that add up to those already achieved by RD support 2007-2013 are considered. These "additional" impacts stem from new beneficiaries to AECM (M10), organic farming (M11) and investments (M04) and they are the key to further decrease GHG emissions from agriculture (see Figure 3b). Since organic farming (M11) and other input-reducing AECM (M10) have been supported since many years, their mitigation impact is already partly included in the national GHG inventory. Positive impacts on GHG emission reduction, as assessed to a situation without support, may therefore not result in an actual decrease of GHG emissions.

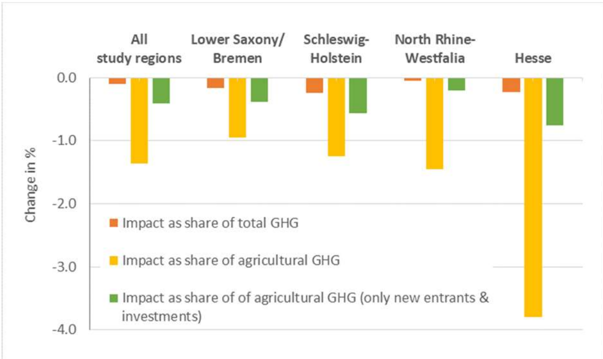
Figure 3b does not include reduced GHG emission attributable to the LULUCF sector (225 kt CO_{2eq}), induced through humus build-up in agricultural soils (M10, M11), forestry measures (M08) and the restoration of bogs (M16). The magnitude of the effects with respect to total LULUCF emissions cannot be quantified, as no figures on LULUCF emissions are available for the study regions so far.

Figure 3a: Impact of RD support on GHG emissions (2015-2018), compared to the situation without RD support



Sources: based upon own calculations and Raue et al (2019), Grajewski et al. (2019), HMUKLV (2019), MKULNV (2019), Roggendorf (2019, 2020)

Figure 3b: Impact of RD support on GHG emissions (2015-2018), compared to the situation without RD support, relative to emissions in 2013

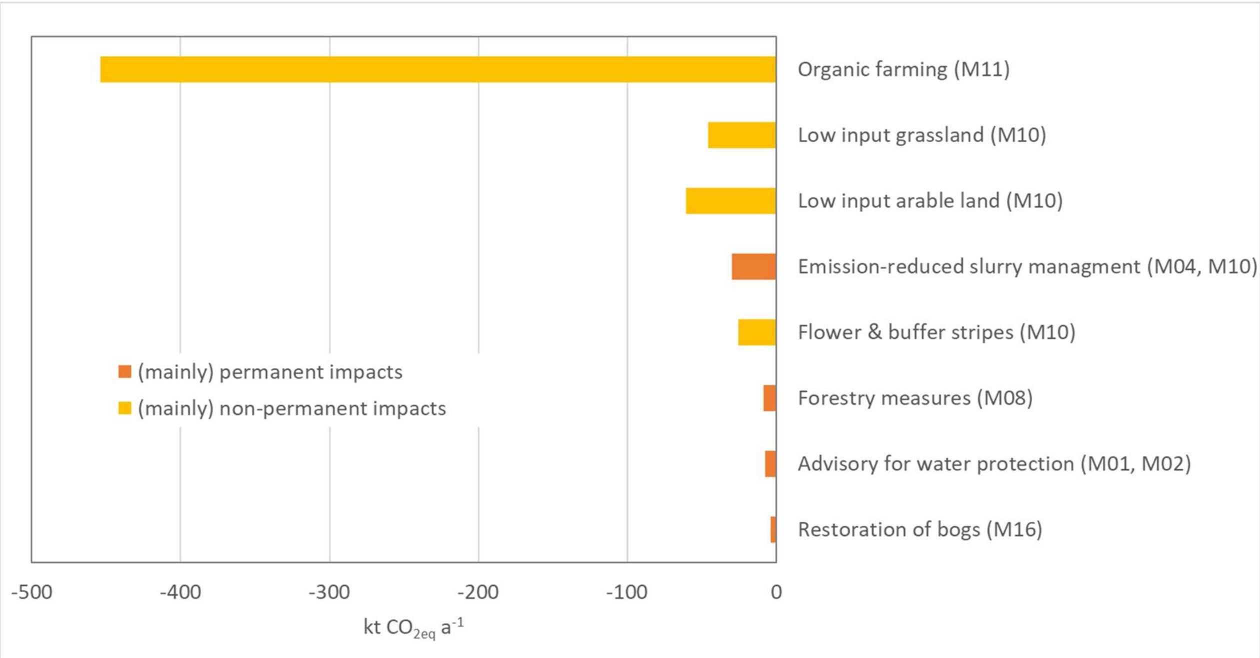


Note: The RD impact on GHG emissions sector LULUCF is not included, since LULUCF emissions per study regions are not available.

Sources: based upon own calculations and Raue et al (2019), Grajewski et al. (2019), HMUKLV (2019), MKULNV (2019), Roggendorf (2019, 2020)

Figure 4 depicts the mitigation impact of single RD measures. Reduced emissions attributable to the agricultural or to the LULUCF sector are included here. About 90 % of emissions reduced stem from organic farming (M11) and AECM (M10). Relevant impact paths are the renunciation of mineral nitrogen fertilisers, the improvement of nitrogen efficiency, reduced livestock densities and the humus build-up in agricultural soils. However, these input-reducing measures result in yield losses and, most likely, in displacement effects that are not considered here. A further drawback is that the input-reduction is not ensured permanently, but for the five-year commitment period only. Hence, achieved emission reductions could be reversed. About 8 % of all impacts result in a mainly permanent reduction of GHG. They are induced by emission-reduced storage and spreading of manure supported through investments (M04) or AECM (M10) (Roggendorf, 2020). Further permanent reductions are expected from advisory support aimed at climate and water protection (M01, M02), forestry (M08) and restoration (M04) measures.

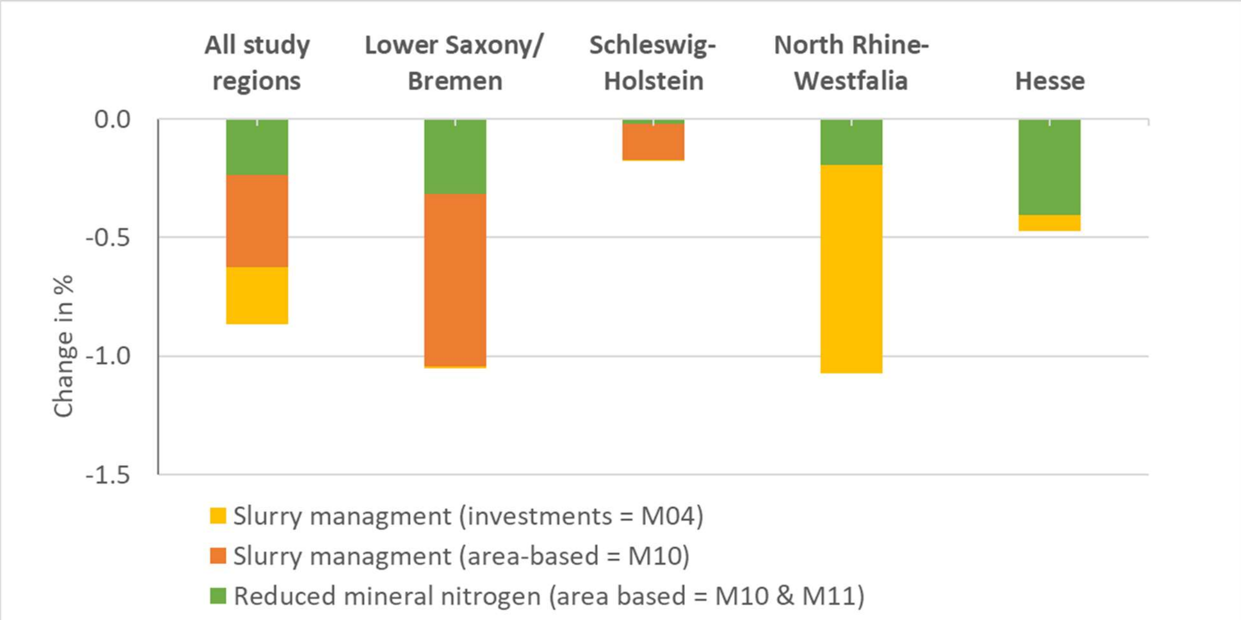
Figure 4: Impact of RD support on GHG emissions (2015-2018) by measure, compared to the situation without RD support



Source: own calculations based upon Raue et al (2019), Grajewski et al. (2019), HMUKLV (2019), MKULNV (2019), Roggendorf (2019, 2020b)

A further RD objective is related to the reduction of ammonia emissions. About 95 % of German ammonia emissions originate from agriculture, and 50 % of those alone from the study regions (UBA, 2020). Between 2015 and 2019, RD support reduced ammonia emissions by 2.7 kt annually or by 0.9 %. About 75 % of this impact is of a mainly permanent nature, induced by measures targeted to the reduction of ammonia emissions. These measures include investment support (M04) and area-based AECM (M10) on improved slurry management (see Figure 5, first column). Reduced use of nitrogen fertiliser through AECM (M10) and organic farming (M11) account for a quarter of reduced ammonia emissions (Roggendorf, 2020; Roggendorf und Schwarze, 2020). To judge the RD impact on ammonia reduction, reference is taken to the NEC directive (NEC-RL 2016/2284/EU). According to it, agricultural ammonia emissions in Germany are to be reduced by 29 % until 2030, compared to emissions in 2020 (Haenel et al., 2020). A 29 %-reduction of ammonia emissions in the study regions would equal a minus of 90 kt NH_3. With this respect, the current RD impact of -0.9 % (-2.7 kt NH_3) is rather low.

Figure 5: Impact of RD support on the reduction of ammonia emissions (2015-2019) by measure, compared to the situation without RD support, relative to emissions in 2015



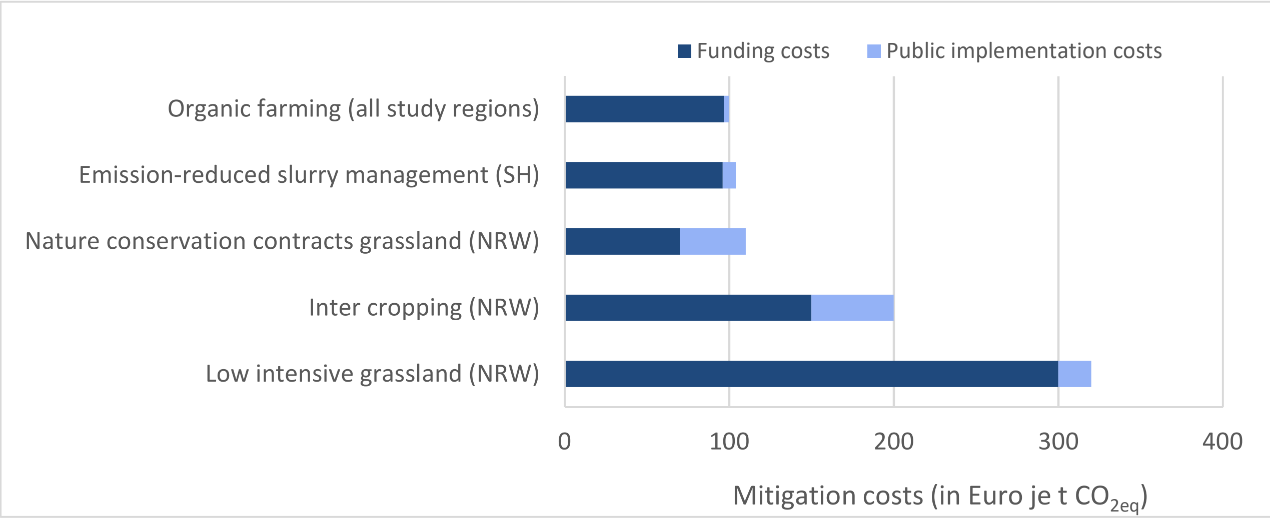
Source: own calculations based upon Raue et al. (2019), Grajewski et al. (2019), HMUKLV (2019), MKULNV (2019), Roggendorf (2019, 2020b)

GHG Mitigation costs

Figure 6 displays the mitigation costs of RD measures, irrespective of whether they were targeted to climate mitigation or not. Displayed measures are those with the lowest migitagion costs. In the 2007-2013 RD programmes studied, mitigation costs were lowest for organic farming (on average over all study regions) and the AECM emission-reduced slurry management in Schleswig-Holstein. For both measures, mitigation costs are around € 100 per ton CO_{2eq} and year. The implementation costs of both measures are relatively low, because they do not require a site-specific implementation and have high uptake rates. Compared to alternative mitigation measures in agriculture, GHG mitigation costs of 100 € are to be considered as moderate. This is all the more true as estimated mitigation costs did not take into account the multifunctional impacts of organic farming and other AECM on biodiversity, water and soil protection as well as on animal welfare.

Support for organic farming (M11) and all other AECM (M10) in Figure 6 is granted annually. To permanently sustain the achieved emission reduction, continous support is required. One exception is the support for the AECM emission-reduced slurry management, which supports the adoption of emission reduced technologies. As soon as the supported technology becomes “State of the Art” in that region, RD support is likely to be ceased. Hence, this measure can achieve lasting effects without permanent support.

Figure 6: Annual GHG mitigation costs for AECM (M10) and organic farming (M11) in RD programmes 2007-2013



Source: Sander et al. (2016a; 2016c, 2016b, 2016d)

The further ranking of RD measures depends on their type, funding scope and their potential to have deadweight effects. Mitigation costs rise if uptake rates are low causing disproportionately high implementation costs or if impacts are low because of high deadweight effects. The RD measures shown in Figure 6 are therefore "standard measures" with low implementation costs due to high uptake rates and low deadweight losses.

Discussion

Our evaluation results suggest that RD support in Germany failed to significantly contribute to climate mitigation. The reduction of GHG and ammonia emissions through RD support were low compared to set reduction targets and mainly of a non-permanent nature. Emission reduction was not a high-ranked objective in RD programmes 2014-2022, since only 3 % of RD expenditures was targeted to that objectives. Climate mitigation is mainly addressed “en passent” through long-existing measures with positive side-effects on emission reduction. If the climate impacts of a future CAP are to be increased, effective measures with permanent impacts need to be implemented to a larger scale. Our analysis shows, that permanent, mainly non-reversable impacts arise from measures specifically targeted to emission reduction, especially in the sector agriculture.

Of the RD measures offered in 2015-2018, investments and AECM supporting emission-reduced management technologies and advisory support targeted to water protection, were effective in reducing emissions in the sector agriculture substantially and permanently. However, these measures contribute to less than 8 % to total GHG emission reduction achieved. There is a need to increase the uptake of these measures and to extent the portfolio of measures targeted to GHG reduction in the sector agriculture substantially. Potential mitigation measures include the replacement of imported concentrate feed with domestic legumes, an increase in the number of lactations per dairy cow, a reduction of ruminant livestock and the use of feed additives (Huber et al., 2022). To implement (some of) these measures in the framework of RD programms, preparatory work to define eligebility requirements and premia calculations is necessary.

RD-induced emission reductions in the LULUCF sector mainly originate from reduced mineral fertilizer use. This impact is largely reversible if RD participation is ceased. Support for forestry measures and peatland rewetting play a minor role so far. However, low uptake rates do not imply inaction in these fields: Numerous support programmes are available outside RD programmes and the use of them is possibly associated with lower transaction costs as the use of RD support. In the last years, forestry owners were mainly concernced with managing forest damages caused by bark beetles and drough. Further more, the implementation of forestry RD support within the framework of the CAP is sometimes difficult, as the stakeholders involved are not so familiar with regulatory framework of the CAP.

From 2023 on, the CAP strategic plan (CAP-SP) adresses climate mitigation through enforced standards of good agricultural and environmental conditions of land (GAEC standards), eco-schemes and (mainly existing) RD measures (BMEL, 2022). The ex-ante evaluation shows that climate mitigation impacts of the CAP-SP are expected to remain limited (IfLS et al., 2022). The evaluation of the CAP-SP will, for the first time, comprise pillar I and pillar II measures. This substantially changes the definition of the contrafactual situation, to which the observed situation with CAP support is to be compared. The questions to be answered than are: Which sites would be abandoned in a contrafactual situation without pillar I and pillar II support? And what would be the (climate) impact of no use of these sites?

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