13. Avoidance of land use change (LUC) from grassland to arable land, Germany

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1. Related practices

Conversion of grassland to cropland and cropland to grassland

2. Description of the case study

The case study is about maintaining grassland instead of converting it to cropland (land use change, LUC) and the benefits of maintaining it as grassland. The measured values cover two sites which have been converted from grassland to cropland. The gains of carbon and soil biodiversity are beneficial when avoiding the conversion of grassland to cropland. It is common that permanent grassland soils have a higher soil carbon density/stock compared to cropland soils. Therefore, the conversion of grassland to cropland soils is always associated with a loss of soil carbon.

The long-term soil monitoring sites are located in the Northern Germany (Schleswig-Holstein) and have been managed by farmers considering both production and economic benefits. The study sites are part of a high-quality soil monitoring network with standardized sampling design since 1989. The aim of the study was to demonstrate the ability of accounting changes in soil carbon in the monitoring network. The measurements were taken before and up to seven years after the conversion of the study sites, so as to consider the sites as a mid-term example.

Since the introduction of European Union (EU) regulation for direct payments from 2013 (Eur-LEX, 2013), it is forbidden to convert permanent grassland to cropland in the EU. Grassland of a minimum age of five years has been defined as permanent grassland. In this case study, the measurements after conversions were done in 2010 and 2019.

3. Context of the case study

The location is Northern Germany, and has a temperate-oceanic climate, and the two sites have a) sandy loam Stagnosol soil (54°24 N, 9°12 E) and b) clay loam Planosol soil (54°19 N, 8°38 E). Both were formerly grassland soils, which were converted to cropland in 2002 (sandy loam soil) and 2009 (clay loam soil).

4. Possibility of scaling up

It is a context-specific case study. The practice can be scaled up in the European Union as there is a prohibition of converting permanent grassland (at least 5 years long) to cropland.

5. Impact on soil organic carbon stocks

The C sequestration values should be interpreted as carbon sequestration potential if the grassland is not converted to cropland. The values in Table 51 were measured after seven (upper row) and one year(s) (lower row) after conversion from grassland to cropland, respectively. Most of the carbon loss always takes place in the first year or within a few years after conversion.

Table 51. Evolution of SOC stocks with conversion of cropland into grassland

Location	Context	Cseq potential (tC/ha)	Cseq potential (tC/ha/year)	Reference
Northern Germany	The measurements included the topsoil (0-30 cm).	19.4	2.82	Nerger, Beylich and Fohrer, (2016)
		27.2	27.2	

6. Other benefits of the practice

6.1. Improvement of soil properties

One of the main benefits of maintaining grassland land use is the higher soil biodiversity compared to the conversion/LUC to cropland. After LUC to cropland, the soil fauna was highly affected, earthworm abundance decreased by 75 percent and their biomass by 86 percent. The measurements were taken 5 years after LUC in a sandy loam soil (Nerger, Beylich and Fohrer, 2016).

Soil microbes were affected as well. The microbial biomass decreased by about 50 percent in the sandy loam soil and ~70 percent in the clay loam soil after LUC. Similar results were observed for the microbial (basal) respiration (Nerger, Beylich and Fohrer, 2016).

In addition, maintenance of grasslands often lowers bulk density and soil compaction compared to cropland. The use of heavy machinery during ploughing and other practices resulted in soil compaction particularly below the plough layers. At the study site, the soil bulk density increased after the conversion of grassland to cropland. However, in some cases the opposite effect may occur, for example in heavy loam or clayey soils where frequent soil tillage or ploughing contributes to a lower topsoil bulk density.

6.2 Minimization of threats to soil functions

Table 52. Soil threats

Soil threats	
Soil erosion	Grassland soils with a sufficient plant coverage could lower soil erosion.
Soil contamination / pollution	Generally: It is possible that cropland is fertilized with sewage sludge or liming. These substances might contain heavy metals. Also, synthetic and organic fertilizers may contain measurable heavy metals contents. These risks would be prevented when avoiding the conversion to cropland.

Soil threats	
Soil biodiversity loss	Biodiversity in grassland soils is much higher than in cropland soils (Nerger, Beylich and Fohrer, 2016).
Soil compaction	May occur if heavy machiney is used on cropland soils.

6.3 Increases in production (e.g. food/fuel/feed/timber)

There can be an effect on food production, as grassland can be used as pasture and thus there is meat or dairy production. At the sites of this case study, there was meat and dairy production which was continued on other field and indoor after conversion to cropland.

6.4 Mitigation of and adaptation to climate change

Another GHG benefit could be the potential saving of (synthetic) fertilizer, which is often used on cropland soils. Even in cases where grassland soils are fertilized the amounts of fertilizer used are lower. Fertilizers, especially synthetic fertilizers feature a high GHG emission footprint due to fertilizer production process but also due to increased N_2O after application.

Furthermore, grassland soils are characterized by a much lower (or non-existent) soil erosion and a much lower nitrate leaching. This saves carbon in the soil and avoids the N_2O emissions.

6.5 Socio-economic benefits

The avoidance of a grassland conversion can mean a financial loss to farmers, as arable land may be more profitable, for example through the European CAP policy of energy crop premiums (which was however ended in 2010). In this case study, the grassland was converted to cropland for the purpose of growing energy crops, which were subsidized by the Government at that time. Since 2015, the Greening policy of the CAP regulates that the avoiding the conversion of environmentally valuable grasslands is coupled to 30 percent of direct payments for farmers receiving an area-based payment.

7. Potential drawbacks to the practice

7.1 Tradeoffs with other threats to soil functions

Table 53. Soil threats

Soil threats	
Soil erosion	Generally, grassland with a sufficient plant coverage could lower soil erosion compared to cropland soils).
Soil contamination / pollution	A possible residual contamination after fertilization with sewage sludge or liming (but also synthetic and organic fertilizers) containing heavy metals may occur.
Soil biodiversity loss	Less biodiversity loss from grassland compared to cropland soils (Nerger, Beylich and Fohrer, 2016).
Soil water management	The conversion of grassland to cropland decreased the non-plant available soil water content and increased aeration. Thus, plant available soil water may improve after conversion to cropland.

7.2 Conflict with other practice(s)

Maintaining grassland instead of converting it to cropland can cause economic conflicts with agricultural practices to adopt, as the former is often profitable more than grassland/pasture farming.

7.3 Other conflicts

Possibly an increase in commodity prices and global demand for cereals and energy crops.

8. Recommendations before implementing the practice

A cost-benefit check should be made, where the benefit side should include not just the direct economic benefits but also the benefits for the soil health, waterbodies, environment, and the agroecosystem. Finally, these could also bring economic benefits as intact agroecosystems with healthy soils, high soil organic matter content and high soil biodiversity are the basis for achieving a long-term sustainable and successful farming.

9. Potential barriers for adoption

Table 54. Potential barriers to adoption

Barrier	YES/NO	
Economic	Yes	The avoidance of a grassland conversion can mean a financial loss to farmers, as arable land may be more profitable. However, specifically in the European Union, this is no longer a barrier (or at least less important) since the Common Agricultural Policy (CAP) changed in 2015 and a significant part of direct payments is coupled to the conservation of permanent grassland.
Legal (Right to soil)	Yes	In case of rented land, it is possible that there might be compulsory conditions for managing the rented land as cropland.
Knowledge	Yes	There might be knowledge gaps in assessing the value of (permanent) grassland, considering all above-mentioned benefits. Likewise, knowledge gaps can exist in making the maintenance of grassland profitable.

Photo

Photo 25. This picture illustrates the negative practice of converting grassland to cropland in the temperate zone (Europe, Germany)

References

EUR-Lex. 2013. Council Regulation (EC) No 1307/2014. [online]. [Cited 17 November 2020]. https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:32013R1307

Nerger, R., Beylich, A., & Fohrer, N. 2016. Long-term monitoring of soil quality changes in Northern Germany. *Geoderma Reg.*, 7(2): 239–249. https://doi.org/10.1016/j.geodrs.2016.04.004