Umwelt Bundesamt

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Low input grasslands / set-aside areas[1]

1 Measure definition

There is no official definition of "low input grasslands" with several different definitions among the literature sometimes referred to as high-nature value grassland, natural grassland, semi-natural grassland, unimproved grassland or extensive grassland.

Low input grassland can be described as an optimized management and use of internal production inputs (e.g. manure management, late mowing, limited livestock density) with minimized or no use of external production inputs such as mineral fertilizer and pesticides and low yielding. A distinction can be made between pasture grazing and meadow use or the combination of both.

Set-aside areas are usually described as arable land taken out of production and out of the crop rotation for a certain time. This can be for one year or longer. In set-aside areas, pesticides and heavy machinery are prohibited and fertilizer application is limited (Rural payments agency 2021).

Grasslands in Europe have a long management history and are part of the cultural landscape. The majority of European grasslands are semi-natural and have a basic role in feeding herbivores and ruminants and provide important ecosystem services, including erosion control, water management and water purification. Grasslands provide important fire-breaks in Mediterranean forest landscapes. Grasslands also support biodiversity and cultural services. Grasslands are an important stock of carbon while the cultivation of grasslands, and other modifications of grasslands through desertification and intensive livestock grazing can be a significant source of carbon emissions. Low input grasslands and set-aside areas can increase the benefits described above especially regarding biodiversity. Both systems are characterized as biodiversity rich habitats in the agricultural area. They are habitats for numerous plant and animal species, rare species of flowers and grasses, for grasshoppers and butterflies, for birds (meadow breeders) and mammals.

Geographical and biophysical applicability

- **Suitability to different biophysical conditions:** Due to the diversity of potential, low input grasslands are suitable for several terrains and climatic regions by adapting species and landscape design. In general, any arable land or permanent grassland can be converted to a low input grassland system or set-aside area. Extensive grazing close to water bodies could lead to nutrient pollution of such and needs to be considered.

- **Suitability in EU/German conditions:** Permanent grassland accounts for almost one third (31.2%) of the utilised agricultural area in Europe and is mainly used to provide fodder and forage for animals (Eurostat 2021). The CAP 2023 will include permanent grassland as part of the conditionality (GAEC 1) as well as a minimum share of agricultural area devoted to non-productive areas or features (GAEC 8).

[1] This factsheet was developed as part of the research project "Naturbasierte Lösungen (NbS) im Klimaschutz: Marktanreize zur Förderung klimaschonender Bodennutzung" (FKZ 3721 42 502 0) and is also published as part of the Annex to the UBA report "Role of soils in climate change mitigation", see www.umweltbundesamt.de/publikationen/Role-of-soils-in-climate-change-mitigation.

Fit with NbS definition

Provided that the management of low-input grasslands is adapted to local conditions they fulfil all aspects of nature-based solutions as defined in the working definition for this research project by Reise et al. (2022).

2 Mitigation Potential

2.1 Soil organic carbon (SOC) sequestration

In general, carbon sequestration increases when grassland management is intensified including an increase of nutrient inputs especially nitrogen (Kätterer et al. 2012). Therefore, low input grasslands and set-aside areas usually have a lower carbon sequestration potential. However, the climate mitigation effect of intensified grassland management may be offset by increased emissions of greenhouse gases other than CO_2. Bellarby et al. (2013) even argue that beef and dairy production on natural grasslands and rough grazing land, as opposed to intensive grain-fed production from croplands, may reduce GHG emissions. Roe et al. (2021) estimate that improved grassland management[2] in the EU could feasibly sequester 27 Mt CO_2e. per year[3].

2.2 Total climate impact

Permanent grasslands store large quantities of carbon in the soil. However, it involves the potential risk of reversal because carbon is rapidly decomposed and released as CO_2 if grasslands are transformed into cropland or managed intensely by ploughing and re-sowing. Intensification of grassland management especially through N fertilization can lead to N_2O emissions that exceed the carbon sequestration potential (Henderson et al. 2015). Apart from direct management interventions, also human-induced climate change is likely to be a threat to soil organic carbon (SOC). Increasing temperatures are acknowledged to catalyse microbial activity and thus SOC mineralisation, inducing a climate-carbon cycle feedback loop (Davidson & Janssens 2006). Grasslands can also be sources of GHG especially due to nutrient application (N_2O).

Integrated assessments that look at the total climate impact on both sequestration and emissions of low input grassland and set aside areas are currently not available. There is need to assess low input grasslands across different locations within the EU to enable a better assessment of how different practices in different biophysical conditions affect the climate, yield, and biodiversity impacts.

2.3 Limitations on the mitigation potential

The mitigation potential of stored carbon and sequestered carbon in grasslands is limited and uncertain due to the heterogeneity of soils, climatic conditions, existing SOC levels, their potential saturation and management practices.

3 Adaptation and co-benefits

- **Biodiversity**: Low input grassland and set aside areas offer a unique biodiversity value, because of moderate human disturbance (Herzon et al. 2021). This includes plant species diversity providing habitats for breeding and migratory birds (Báldi et al. 2013),

[2] Enhanced soil organic carbon sequestration in managed pastures, by shifting from current practices to improved sustainable management with light to moderate grazing pressure and at least one improvement. For rangelands, a shift from current management defined by land degradation to nominally managed.

[3] The technical mitigation potential of improved grassland management in the EU is estimated to 45 Mt CO_2 per year.

invertebrates, fungi and other organisms. Usually, the plant species diversity is rather small-scale with a high share of indigenous and endemic species including red-listed species (Wilsen et al. 2012; Eriksson 2014).

- **Soil**: Grasslands in Europe (including intensive farming grassland) are estimated to store 5.5 Gt of carbon in the top 30 cm of soils (Lugato et al. 2014). High livestock grazing intensity significantly increases the SOC storage and soil quality (bulk density, pH), however climatic conditions and grassland types need to be considered (Lugato et al. 2014, Abdalla et al. 2018). Study results indicate that semi-natural grasslands can lead to an increased nutrient cycling and nutrient retention (Pecina et al. 2019). Soil microbial biomass increases in set-aside areas of formerly agricultural land. This comes along with a change in the microbiological community structure and a greater microbial C:N ratio that results in reduced C and N turnover rates (Landgraf et al, 2001). Set-aside areas after intensive cultivation restore soil metabolic activity and soil fertility (Masciandaro et al. 1998).
- **Pollination**: One of the main benefits of grassland positively affecting agricultural protection are pollination and biological control. Especially insect-pollinating crops have potentially higher pollination close to grassland areas (Werling et al. 2014). However, there is only limited research on grassland and crop pollination interaction.
- **Prevention of erosion**: Permanent soil cover generally protects against soil erosion by reducing water run-off, and stabilizing the soil. Grasslands in general can contribute to soil erosion prevention (<10% compared to soil erosion on cropland) if managed appropriately and without overgrazing (Cerdan et al. 2010). In general, erosion reduces with vegetation cover, therefore forests have an even lower risk of erosion compared to grassland.
- **Water services:** Natural and semi-natural grasslands can improve the water quality and regulate the water flow (Bengtsson et al. 2019). However, compared to forest the water supply is rather small due to small-scale plot sizes.
- **Cultural services**: Natural and semi-natural grasslands are an important landscape feature throughout Europe offering several cultural ecosystem services. These include tourism, recreation, hunting, cultural heritage (e.g., burial mounds) and scientific studies (Bengtsson et al. 2019).

4 Trade offs

- **Management:** The effect of carbon sequestration is reversed, when the set-aside area is reused for intensive cultivation.
- **Yields**: Low-input grasslands and set-aside areas are generally low-yield systems due to reduced inputs. This includes fodder quantity and quality. Especially digestibility is an important factor for meat and dairy production and is lower compared to high input grasslands. However, a direct linkage between fodder and livestock quality needs to be assessed carefully, including definitions of meat and dairy quality criteria (e. g. taste, texture, aroma) (Bengtsson et al. 2019).

5 Implementation challenges

Grasslands in Europe have played an important role throughout history especially for fodder production for livestock (Emanuelsson 2009). During the last century natural and semi-natural grasslands have declined and have been fragmented due to conversion to arable land, intensive grassland, settlement area and infrastructure. In the United Kingdom around 90% of the semi-natural grasslands have been lost since 1945. Therefore, implementation challenges are mainly around halting the trend of declining grasslands rather than reversing this trend.

Especially the trade-offs on yield and production hinder farmers' continued low-input management. There are missing incentives for farmers to compensate yield loses on low input grasslands and set-aside areas.

Research on ecosystem services, biodiversity, fodder, meat and dairy production, as well as monitoring on low input grasslands as a basis to support policymaking is also missing.

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