Project brief

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CarboHedge – carbon sequestration via hedgerows

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- **A project to quantify the potential for CO_2 sequestration through hedgerow replanting and the carbon stocks of hedgerows across Germany.**
- **Hedges store around 140 tonnes more carbon per hectare compared to fields.**
- **The majority (80%) of the additional carbon is stored in the biomass, but soil carbon stocks under the hedges are also increased.**

Background, objectives and approach

Hedges have the potential to contribute to climate mitigation. If new hedges are planted, CO_2 from the atmosphere can be bound in the biomass and soil organic carbon - resulting in so-called negative emissions. These are the focus of attention as they are intended to make a significant contribution to our climate mitigation goals, for example to compensate for unavoidable emissions.

The CarboHedge project investigated how much CO_2 can be sequestered in biomass and as soil carbon when hedges are replanted. To this end, the carbon storage in all carbon pools was quantified by analysing existing data on carbon storage in hedges and obtaining new data from across Germany. The carbon stock of a directly adjacent agricultural reference area (cropland or grassland) was also always analysed. The comparison with this reference area makes it possible to calculate how much CO_2 is sequestered when a hedge is planted on such an area.

Central results

The main climate mitigation effect (around 80%) of hedgerow planting is the CO_2 sequestration in the biomass of the hedgerow plants. According to an estimate based on literature data and our own data on above-ground hedge biomass, a long-term average of 92 ± 40 tonnes of carbon was stored in the biomass per hectare of hedge. However, data on below-ground biomass in particular had hardly been available until now. For this reason, three sites in Schleswig-Holstein with a total of nine old hedgerows were investigated in more detail. For this purpose, both above-ground biomass was harvested and the roots and litter of the hedges were sampled. Result: On a long-term average, around 105 ± 11 tonnes of carbon were stored per hectare in the total biomass of the approximately 300-year-old hedges (Fig. 1) - comparable with the first estimate. A further 11 ± 2 tonnes of carbon were stored in the litter and in the dead roots. The distribution of the biomass carbon pools was surprising: The most important carbon pools were not the branches and twigs above ground,

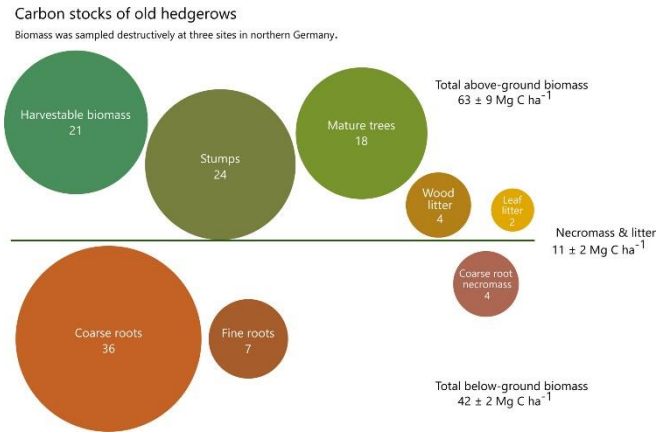

Figure 1: Mean biomass carbon stocks in hedges in ton per hectare from three hedgerow sites in Schleswig-Holstein. Particular high carbon stock was detected below ground as roots (Source: Drexler et al., 2024).

but the roots. The stumps that remain when hedges are pruned also store a lot of carbon.

In order to quantify carbon storage in the soil, existing studies were first analysed. These showed that on average 32 ± 23% more carbon is stored as soil organic carbon under hedges in the temperate zone compared to neighbouring cropland soils. There was no significant difference in soil carbon stocks compared to grassland soils. This estimate was also confirmed by our own Germany-wide sampling of 23 hedgerow sites, always in comparison to croplands. The sites were a representative selection of German hedges and differed in terms of climate, soil type, hedge age and hedge type. For 21 of the 23 sites, the soil carbon stock under the hedge was higher than in the reference field. On average across all sites, around 29 ± 22 tonnes of carbon per hectare was stored more in the hedgerow soil, which corresponds to a relative increase in soil carbon stocks of 36 ± 49%. A particularly large effect (39 ± 61% increase compared to cropland) was found in the subsoil (30-100 cm depth). In addition, carbon stocks were increased not only directly under the hedge, but also in the fringe area and in the cropland adjacent to the hedge (Fig. 2).

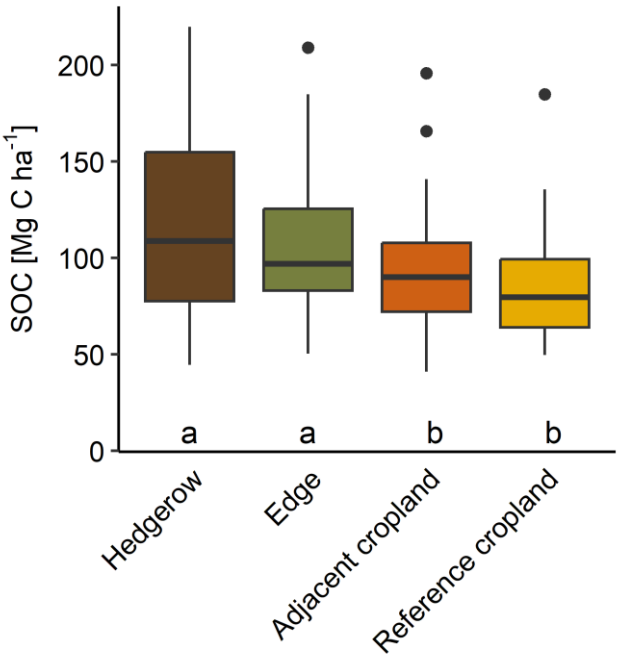

Figure 2: Mean carbon stocks in the soil (SOC) to a depth of 1 m under hedges compared with the neighbouring grassland edge, the directly adjacent arable field (1 m distance) and the reference arable field (30 m distance) - (Source: Drexler & Don, 2024).

The additional carbon storage of new hedges was calculated as the long-term average carbon storage (Fig. 3). However, it takes around 20 years for a hedge to grow. In the soil, it takes even longer (50 years or more) for the soil carbon stocks to reach a new equilibrium. In addition, the carbon stocks of a hedge fluctuate over time, as hedges must be regularly maintained in order to preserve their functions: Every 10-15 years, hedges should be pruned in sections, i.e., the above-ground crop biomass is removed. These temporal dynamics must be included in carbon balances: The long-term average carbon stock is independent of these pruning-induced fluctuations.

The additional carbon storage of new hedges can be counted only once as a climate mitigation measure. Alternatively, an annual sequestration rate can be calculated. The standard method is to divide the long-term additional average carbon stock by the growth period of 20 years.

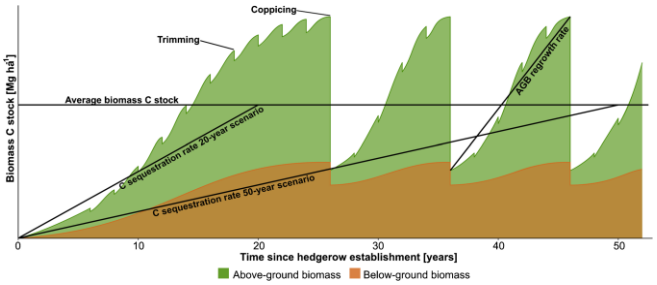

Figure 3: Schematic overview of the carbon sequestration capacity of hedges depending on the time after hedge planting. The long-term average carbon storage can be taken into account once (Source: Drexler et al., 2021).

Conclusion

Taking all carbon pools together, hedges store a total of around 220 tonnes of carbon per hectare. Compared to the average carbon storage of a field, this is around 140 tonnes more carbon per hectare. Over a period of 20 years, a hedge can bind around 25 tonnes of CO_2 per hectare per year. The pruning of hedges offers additional potential for climate mitigation by using them as a renewable energy source, Hedgerow derived wood chippings can replace oil and gas which further increase the climate mitigation effect of hedges. Charring the cuttings to produce biochar could also gain importance as a climate mitigation option in the future, as this would create an additional long-term carbon sink. There is hardly any other climate mitigation measure in the agricultural sector that can achieve so much climate impact on such a small area. The project showed that hedges can also contribute to climate mitigation in addition to the many other positive functions of hedges, such as for biodiversity or soil protection.

Further information

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Publications

Drexler S, Gensior A, Don A (2021): Carbon sequestration in hedgerowrow biomass and soil in the temperate climate zone. Reg Environ Change.

Drexler S, Thiessen E, Don A (2024): Carbon storage in old hedgerowrows: The importance of below-ground biomass. GCB-Bioenegy.

Drexler S, Don A (2024): Carbon sequestration potential in hedgerowrow soils: Results from 23 sites in Germany. Geoderma.

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