# Effects of mowing, grazing and fertilization on soil seed banks in temperate grasslands in Central Europe

**Journal Article**

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## Supplementary material

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## Tables

Table S1. Environmental conditions of the three study regions according to Fischer et al. (2010).

| | **Study region** | | |
|---|---|---|---|
| **Toponym** | Hainich-Dün | Schorfheide-Chorin | Schwäbische Alb |
| **Location in Germany** | Central | Northeast | Southwest |
| **Geology** | Calcareous bedrock with loess layer | Rather flat post-glacial landscape with sandy ridges and fens | Calcareous bedrock with loam layer and karst phenomenon |
| **Dominant soil types** (WRB) | Cambisols, Stagnosols and Vertisols | Histosols, Gleysols, Cambisols, Luvisols and Albeluvisols | Leptosols and Cambisols |
| **Elevation** (m a.s.l.) | 285–550 | 3–140 | 460–860 |
| **Annual temperature** (°C) | 6.5–8.0 | 8.0–8.5 | 6.0–7.0 |
| **Annual precipitation** (mm) | 500–800 | 500–600 | 700–1000 |
| **pH $CaCl_2$** | 6.9 (5.0/7.5) | 6.4 (4.6/7.4) | 6.3 (5.1/7.3) |
| **Silt fraction** ($g*kg^{-1}$) | 520 (335/871) | 372 (72/713) | 407 (213/757) |
| **Soil organic carbon** ($g*kg^{-1}$) | 45.6 (20.8/79.6) | 105.8 (12.2/359.5) | 65.1 (39.5/93.7) |

Reference:

1. Fischer, M., Bossdorf, O., Gockel, S., Hänsel, F., Hemp, A., Hessenmöller, D., Korte, G., Nieschulze, J., Pfeiffer, S., Prati, D., Renner, S., Schöning, I., Schumacher, U., Wells, K., Buscot, F., Kalko, E.K.V., Linsenmair, K.E., Schulze, E.-D., Weisser, W.W., 2010. Implementing largescale and long-term functional biodiversity research: the biodiversity exploratories. Basic Appl. Ecol. 11, 473–485.

Table S2. Plant species lists of both sampling approaches. Mean, minimum and maximum over all study plots of the respective sampling given. Frequency is the number of occurrences divided by the number of sampled plots (n = 73 each). *Typical GL* refers to all species which are typical elements of temperate grassland ecosystems in Europe (Ellenberg and Leuschner, 2010). NA means that the species had to be completely excluded from the sampling due to contamination of germination trays by external seeds.

| | | Autumn | | | | Spring | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Plant species** | ***Typical GL*** | **Mean** | **Max** | **Min** | **Frequency** | **Mean** | **Max** | **Min** | **Frequency** |
| *Achillea millefolium* | *x* | 0.47 | 16 | 0 | 15.07% | 0.19 | 5 | 0 | 12.33% |
| *Acinos arvensis* | *x* | 0.00 | 0 | 0 | 0.00% | 0.10 | 5 | 0 | 4.11% |
| *Aethusa cynapium* | | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Agrimonia eupatoria* | *x* | 0.04 | 2 | 0 | 2.74% | 0.00 | 0 | 0 | 0.00% |
| *Agrostis capillaris* | *x* | 0.74 | 13 | 0 | 15.07% | 0.42 | 9 | 0 | 19.18% |
| *Agrostis stolonifera* | *x* | 0.40 | 11 | 0 | 20.55% | 1.12 | 17 | 0 | 24.66% |
| *Ajuga reptans* | *x* | 0.34 | 14 | 0 | 4.11% | 0.00 | 0 | 0 | 0.00% |
| *Alchemilla vulgaris agg.* | *x* | 0.42 | 8 | 0 | 12.33% | 0.34 | 15 | 0 | 5.48% |
| *Alopecurus pratensis* | *x* | 0.45 | 5 | 0 | 21.92% | 0.00 | 0 | 0 | 0.00% |
| *Anagallis arvensis* | | 0.10 | 3 | 0 | 5.48% | 0.03 | 1 | 0 | 2.74% |
| *Anthoxanthum odoratum* | *x* | 0.10 | 4 | 0 | 5.48% | 0.00 | 0 | 0 | 0.00% |
| *Anthriscus sylvestris* | *x* | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Anthyllis vulneraria* | *x* | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Aphanes arvensis* | | 0.14 | 4 | 0 | 5.48% | 0.03 | 1 | 0 | 2.74% |
| *Arabis hirsuta* | *x* | 0.01 | 1 | 0 | 1.37% | 0.19 | 4 | 0 | 9.59% |
| *Arabidopsis thaliana* | | 0.01 | 1 | 0 | 1.37% | 0.01 | 1 | 0 | 1.37% |
| *Arenaria serpyllifolia* | *x* | 0.08 | 1 | 0 | 8.22% | 0.14 | 3 | 0 | 8.22% |
| *Barbarea vulgaris* | | 0.00 | 0 | 0 | 0.00% | 0.03 | 2 | 0 | 1.37% |
| *Bellis perennis* | *x* | 0.22 | 12 | 0 | 5.48% | 0.00 | 0 | 0 | 0.00% |
| *Berteroa incana* | | 0.00 | 0 | 0 | 0.00% | 0.05 | 3 | 0 | 2.74% |
| *Betula pendula* | | 0.00 | 0 | 0 | 0.00% | 1.04 | 17 | 0 | 20.55% |
| *Brachypodium pinnatum* | *x* | 0.03 | 2 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Brassica napus* | | 0.00 | 0 | 0 | 0.00% | 0.01 | 1 | 0 | 1.37% |
| *Brassica rapa* | | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Briza media* | *x* | 0.00 | 0 | 0 | 0.00% | 0.01 | 1 | 0 | 1.37% |
| *Bromus erectus* | *x* | 0.00 | 0 | 0 | 0.00% | 0.01 | 1 | 0 | 1.37% |
| *Bromus hordeaceus* | *x* | 0.00 | 0 | 0 | 0.00% | 0.01 | 1 | 0 | 1.37% |
| *Campanula patula* | *x* | 0.32 | 11 | 0 | 5.48% | 0.00 | 0 | 0 | 0.00% |
| *Campanula rotundifolia* | *x* | 0.38 | 16 | 0 | 6.85% | 0.08 | 2 | 0 | 5.48% |
| *Capsella bursa-pastoris* | | 0.92 | 15 | 0 | 27.40% | 1.90 | 37 | 0 | 30.14% |
| *Cardamine hirsuta* | | 0.53 | 4 | 0 | 34.25% | 0.10 | 2 | 0 | 8.22% |
| *Cardamine impatiens* | | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Cardamine pratensis* | *x* | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Carex caryophyllea* | *x* | 0.08 | 3 | 0 | 5.48% | 0.00 | 0 | 0 | 0.00% |
| *Carex flacca* | *x* | 0.11 | 4 | 0 | 5.48% | 0.05 | 3 | 0 | 2.74% |
| *Carex hirta* | *x* | 0.18 | 8 | 0 | 4.11% | 0.16 | 6 | 0 | 8.22% |
| *Centaurium erythraea* | *x* | 0.08 | 5 | 0 | 2.74% | 0.00 | 0 | 0 | 0.00% |
| *Centaurea jacea* | *x* | 0.00 | 0 | 0 | 0.00% | 0.03 | 1 | 0 | 2.74% |
| *Cerastium glomeratum* | *x* | 0.25 | 3 | 0 | 17.81% | 0.00 | 0 | 0 | 0.00% |
| *Cerastium holosteoides* | *x* | 1.77 | 19 | 0 | 57.53% | 1.29 | 16 | 0 | 45.21% |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Cerastium semidecandrum* | *x* | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Chenopodium album* | | 0.10 | 3 | 0 | 6.85% | 0.42 | 12 | 0 | 15.07% |
| *Chenopodium polyspermum* | | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Chenopodium rubrum* | | 0.00 | 0 | 0 | 0.00% | 0.12 | 6 | 0 | 5.48% |
| *Cirsium acaule* | *x* | 0.08 | 5 | 0 | 2.74% | 0.00 | 0 | 0 | 0.00% |
| *Cirsium arvense* | | 0.00 | 0 | 0 | 0.00% | 0.04 | 3 | 0 | 1.37% |
| *Cirsium oleraceum* | *x* | 0.07 | 2 | 0 | 5.48% | 0.00 | 0 | 0 | 0.00% |
| *Cirsium vulgare* | | 0.00 | 0 | 0 | 0.00% | 0.04 | 2 | 0 | 2.74% |
| *Convolvulus arvensis* | *x* | 0.00 | 0 | 0 | 0.00% | 0.01 | 1 | 0 | 1.37% |
| *Conyza canadensis* | | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Crepis biennis* | *x* | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Cruciata laevipes* | *x* | 0.03 | 2 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Cyperus flavescens* | | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Dactylis glomerata* | *x* | 0.21 | 3 | 0 | 12.33% | 0.04 | 1 | 0 | 4.11% |
| *Daucus carota* | *x* | 0.48 | 6 | 0 | 13.70% | 0.63 | 11 | 0 | 10.96% |
| *Deschampsia cespitosa* | *x* | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Digitaria sanguinalis* | | 0.04 | 1 | 0 | 4.11% | 0.00 | 0 | 0 | 0.00% |
| *Elymus caninus* | | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Elymus repens* | *x* | 0.30 | 4 | 0 | 16.44% | 0.00 | 0 | 0 | 0.00% |
| *Epilobium tetragonum* | | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Erigeron annuus* | *x* | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Erodium cicutarium* | | 0.07 | 5 | 0 | 1.37% | 0.01 | 1 | 0 | 1.37% |
| *Erophila verna* | *x* | 0.56 | 8 | 0 | 21.92% | 0.36 | 8 | 0 | 21.92% |
| *Erysimum cheiranthoides* | | 0.04 | 2 | 0 | 2.74% | 0.00 | 0 | 0 | 0.00% |
| *Euphorbia cyparissias* | *x* | 0.18 | 5 | 0 | 9.59% | 0.07 | 5 | 0 | 1.37% |
| *Euphorbia exigua* | | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Euphorbia helioscopia* | | 0.03 | 1 | 0 | 2.74% | 0.00 | 0 | 0 | 0.00% |
| *Euphorbia maculata* | | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Euphrasia rostkoviana agg.* | *x* | 0.12 | 5 | 0 | 4.11% | 0.00 | 0 | 0 | 0.00% |
| *Fallopia convolvulus* | | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Festuca arundinacea* | *x* | 0.00 | 0 | 0 | 0.00% | 0.01 | 1 | 0 | 1.37% |
| *Festuca pratensis* | *x* | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Festuca rubra agg.* | *x* | 0.03 | 1 | 0 | 2.74% | 0.33 | 6 | 0 | 15.07% |
| *Fumaria officinalis* | | 0.01 | 1 | 0 | 1.37% | 0.03 | 1 | 0 | 2.74% |
| *Galium aparine* | | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Galium mollugo agg.* | *x* | 0.34 | 4 | 0 | 16.44% | 0.22 | 4 | 0 | 13.70% |
| *Galium pumilum* | *x* | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Geranium dissectum* | *x* | 0.03 | 2 | 0 | 1.37% | 0.26 | 9 | 0 | 10.96% |
| *Geranium molle* | | 0.00 | 0 | 0 | 0.00% | 0.12 | 6 | 0 | 4.11% |
| *Geranium pusillum* | | 0.04 | 3 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Geranium pyrenaicum* | | 0.03 | 2 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Geranium rotundifolium* | | 0.12 | 6 | 0 | 4.11% | 0.00 | 0 | 0 | 0.00% |
| *Geranium sylvaticum* | *x* | 0.03 | 2 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Glechoma hederacea* | *x* | 0.15 | 3 | 0 | 8.22% | 0.44 | 7 | 0 | 19.18% |
| *Gnaphalium uliginosum* | | 0.00 | 0 | 0 | 0.00% | 0.01 | 1 | 0 | 1.37% |
| *Helictotrichon pubescens* | *x* | 0.14 | 3 | 0 | 9.59% | 0.00 | 0 | 0 | 0.00% |
| *Heracleum sphondylium* | *x* | 0.29 | 8 | 0 | 5.48% | 0.00 | 0 | 0 | 0.00% |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Holcus lanatus* | *x* | 1.25 | 50 | 0 | 20.55% | 0.22 | 5 | 0 | 12.33% |
| *Hypericum perforatum* | *x* | 2.49 | 42 | 0 | 27.40% | 0.29 | 11 | 0 | 9.59% |
| *Hypochaeris radicata* | *x* | 0.10 | 4 | 0 | 4.11% | 0.00 | 0 | 0 | 0.00% |
| *Juncus articulatus* | *x* | 0.81 | 33 | 0 | 15.07% | 0.00 | 0 | 0 | 0.00% |
| *Juncus bufonius* | *x* | 0.60 | 12 | 0 | 12.33% | 0.00 | 0 | 0 | 0.00% |
| *Juncus inflexus* | *x* | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Koeleria macrantha* | *x* | 0.03 | 1 | 0 | 2.74% | 0.00 | 0 | 0 | 0.00% |
| *Lamium album* | | 0.08 | 4 | 0 | 2.74% | 0.00 | 0 | 0 | 0.00% |
| *Lamium purpureum* | | 0.15 | 3 | 0 | 10.96% | 0.63 | 14 | 0 | 17.81% |
| *Lapsana communis* | | 0.00 | 0 | 0 | 0.00% | 0.01 | 1 | 0 | 1.37% |
| *Lathyrus pratensis* | *x* | 0.08 | 2 | 0 | 6.85% | 0.00 | 0 | 0 | 0.00% |
| *Leontodon autumnalis* | *x* | 0.34 | 9 | 0 | 10.96% | 0.23 | 10 | 0 | 6.85% |
| *Leucanthemum vulgare agg.* | *x* | 0.21 | 5 | 0 | 10.96% | 0.62 | 14 | 0 | 19.18% |
| *Linaria vulgaris* | *x* | 0.08 | 6 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Linum catharticum* | *x* | 0.00 | 0 | 0 | 0.00% | 0.15 | 4 | 0 | 6.85% |
| *Lolium perenne* | *x* | 0.05 | 1 | 0 | 5.48% | 0.01 | 1 | 0 | 1.37% |
| *Lotus corniculatus* | *x* | 0.12 | 3 | 0 | 6.85% | 0.07 | 2 | 0 | 5.48% |
| *Luzula campestris* | *x* | 0.07 | 2 | 0 | 4.11% | 0.00 | 0 | 0 | 0.00% |
| *Lysimachia nummularia* | *x* | 0.22 | 5 | 0 | 9.59% | 0.00 | 0 | 0 | 0.00% |
| *Matricaria discoidea* | | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Medicago lupulina* | *x* | 0.30 | 5 | 0 | 16.44% | 0.37 | 4 | 0 | 19.18% |
| *Myosotis arvensis* | *x* | 0.12 | 5 | 0 | 5.48% | 0.12 | 2 | 0 | 10.96% |
| *Odontites vernus* | *x* | 0.12 | 4 | 0 | 4.11% | 0.00 | 0 | 0 | 0.00% |
| *Ononis repens* | *x* | 0.00 | 0 | 0 | 0.00% | 0.05 | 4 | 0 | 1.37% |
| *Origanum vulgare* | *x* | 0.10 | 7 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Papaver dubium* | | 0.08 | 6 | 0 | 1.37% | 0.05 | 2 | 0 | 2.74% |
| *Persicaria maculosa* | *x* | 0.00 | 0 | 0 | 0.00% | 0.04 | 1 | 0 | 4.11% |
| *Phleum pratense* | *x* | 0.12 | 4 | 0 | 6.85% | 0.12 | 6 | 0 | 4.11% |
| *Pimpinella saxifraga* | *x* | 0.05 | 3 | 0 | 2.74% | 0.01 | 1 | 0 | 1.37% |
| *Plantago lanceolata* | *x* | 4.59 | 89 | 0 | 41.10% | 2.14 | 28 | 0 | 49.32% |
| *Plantago major* | *x* | 2.08 | 31 | 0 | 35.62% | 2.85 | 33 | 0 | 35.62% |
| *Plantago media* | *x* | 1.26 | 17 | 0 | 23.29% | 0.53 | 28 | 0 | 8.22% |
| *Poa annua* | | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Poa pratensis* | *x* | 0.62 | 6 | 0 | 32.88% | 2.03 | 14 | 0 | 65.75% |
| *Poa trivialis* | *x* | 3.49 | 26 | 0 | 71.23% | 3.74 | 32 | 0 | 71.23% |
| *Polygonum aviculare* | | 0.12 | 2 | 0 | 8.22% | 0.11 | 1 | 0 | 10.96% |
| *Polygonum lapathifolium* | | 0.00 | 0 | 0 | 0.00% | 0.12 | 5 | 0 | 6.85% |
| *Polygonum persicaria* | | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Portulaca oleracea* | | 0.12 | 4 | 0 | 8.22% | 0.00 | 0 | 0 | 0.00% |
| *Potentilla anserina* | *x* | 0.11 | 4 | 0 | 2.74% | 0.01 | 1 | 0 | 1.37% |
| *Potentilla reptans* | *x* | 0.70 | 38 | 0 | 5.48% | 0.37 | 17 | 0 | 5.48% |
| *Potentilla verna agg.* | *x* | 0.10 | 5 | 0 | 2.74% | 0.22 | 11 | 0 | 4.11% |
| *Prunella vulgaris* | *x* | 0.08 | 3 | 0 | 5.48% | 0.08 | 2 | 0 | 5.48% |
| *Ranunculus acris* | *x* | 1.12 | 20 | 0 | 24.66% | 0.68 | 15 | 0 | 9.59% |
| *Ranunculus bulbosus* | *x* | 1.10 | 21 | 0 | 30.14% | 0.05 | 1 | 0 | 5.48% |
| *Ranunculus ficaria* | | 0.14 | 9 | 0 | 2.74% | 0.00 | 0 | 0 | 0.00% |
| *Ranunculus repens* | *x* | 0.07 | 3 | 0 | 4.11% | 0.95 | 8 | 0 | 32.88% |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Rhinanthus alectorolophus* | *x* | 0.07 | 5 | 0 | 1.37% | 0.01 | 1 | 0 | 1.37% |
| *Rhinanthus minor* | *x* | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Rorippa palustris* | *x* | 0.00 | 0 | 0 | 0.00% | 0.03 | 2 | 0 | 1.37% |
| *Rumex acetosa* | *x* | 0.29 | 17 | 0 | 5.48% | 0.16 | 4 | 0 | 9.59% |
| *Rumex acetosella* | *x* | 0.26 | 9 | 0 | 5.48% | 0.27 | 11 | 0 | 6.85% |
| *Rumex crispus* | *x* | 0.07 | 2 | 0 | 5.48% | 0.14 | 5 | 0 | 6.85% |
| *Rumex obtusifolius* | *x* | 0.97 | 25 | 0 | 13.70% | 0.71 | 31 | 0 | 13.70% |
| *Sagina procumbens* | | 0.03 | 1 | 0 | 2.74% | 0.04 | 2 | 0 | 2.74% |
| *Sanguisorba minor* | *x* | 0.07 | 2 | 0 | 5.48% | 0.03 | 1 | 0 | 2.74% |
| *Saxifraga tridactylites* | *x* | 0.04 | 3 | 0 | 1.37% | 0.01 | 1 | 0 | 1.37% |
| *Scabiosa columbaria* | *x* | 0.07 | 4 | 0 | 2.74% | 0.05 | 2 | 0 | 4.11% |
| *Senecio vulgaris* | | NA | NA | NA | NA | 0.07 | 1 | 0 | 6.85% |
| *Sinapis arvensis* | | 0.11 | 8 | 0 | 1.37% | 0.14 | 10 | 0 | 1.37% |
| *Sonchus arvensis* | | 0.00 | 0 | 0 | 0.00% | 0.04 | 2 | 0 | 2.74% |
| *Sonchus asper* | | 1.15 | 12 | 0 | 54.79% | 0.03 | 1 | 0 | 2.74% |
| *Sonchus oleraceus* | | 0.03 | 1 | 0 | 2.74% | 0.00 | 0 | 0 | 0.00% |
| *Stellaria graminea* | *x* | 0.03 | 2 | 0 | 1.37% | 0.08 | 4 | 0 | 4.11% |
| *Stellaria media* | *x* | 0.23 | 6 | 0 | 8.22% | 0.45 | 10 | 0 | 16.44% |
| *Symphytum officinale* | *x* | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Taraxacum sect. Ruderalia* | *x* | 2.37 | 13 | 0 | 76.71% | 1.15 | 8 | 0 | 50.68% |
| *Teucrium montanum* | *x* | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Thlaspi arvense* | | 0.29 | 12 | 0 | 6.85% | 0.78 | 30 | 0 | 12.33% |
| *Thlaspi perfoliatum* | | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Thymus pulegioides* | *x* | 0.29 | 6 | 0 | 8.22% | 0.41 | 12 | 0 | 8.22% |
| *Tragopogon pratensis* | *x* | 0.00 | 0 | 0 | 0.00% | 0.03 | 2 | 0 | 1.37% |
| *Trifolium campestre* | *x* | 0.10 | 3 | 0 | 4.11% | 0.74 | 22 | 0 | 17.81% |
| *Trifolium dubium* | *x* | 0.44 | 15 | 0 | 8.22% | 0.00 | 0 | 0 | 0.00% |
| *Trifolium pratense* | *x* | 0.66 | 12 | 0 | 26.03% | 0.27 | 3 | 0 | 20.55% |
| *Trifolium repens* | *x* | 3.42 | 27 | 0 | 67.12% | 4.15 | 52 | 0 | 58.90% |
| *Trisetum flavescens* | *x* | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Tussilago farfara* | *x* | 0.00 | 0 | 0 | 0.00% | 0.01 | 1 | 0 | 1.37% |
| *Urtica dioica* | | 0.53 | 7 | 0 | 21.92% | 0.38 | 13 | 0 | 12.33% |
| *Valerianella locusta* | | 0.01 | 1 | 0 | 1.37% | 0.01 | 1 | 0 | 1.37% |
| *Veronica arvensis* | *x* | 0.36 | 4 | 0 | 20.55% | 2.03 | 12 | 0 | 52.05% |
| *Veronica chamaedrys* | *x* | 0.84 | 8 | 0 | 34.25% | 0.00 | 0 | 0 | 0.00% |
| *Veronica hederifolia* | *x* | 0.12 | 5 | 0 | 5.48% | 0.03 | 1 | 0 | 2.74% |
| *Veronica peregrina* | | 0.04 | 1 | 0 | 4.11% | 0.00 | 0 | 0 | 0.00% |
| *Veronica persica* | *x* | 0.07 | 2 | 0 | 5.48% | 0.00 | 0 | 0 | 0.00% |
| *Veronica serpyllifolia* | *x* | 1.60 | 28 | 0 | 30.14% | 2.25 | 58 | 0 | 20.55% |
| *Vicia cracca* | *x* | 0.03 | 1 | 0 | 2.74% | 0.10 | 3 | 0 | 6.85% |
| *Vicia hirsuta* | *x* | 0.00 | 0 | 0 | 0.00% | 0.01 | 1 | 0 | 1.37% |
| *Vicia sativa agg.* | *x* | 0.08 | 5 | 0 | 2.74% | 0.03 | 2 | 0 | 1.37% |
| *Vicia sepium* | *x* | 0.01 | 1 | 0 | 1.37% | 0.00 | 0 | 0 | 0.00% |
| *Viola arvensis* | *x* | 0.04 | 2 | 0 | 2.74% | 0.04 | 1 | 0 | 4.11% |
| *Viola hirta* | *x* | 0.05 | 3 | 0 | 2.74% | 0.00 | 0 | 0 | 0.00% |

Reference:

Ellenberg, H., Leuschner, C., 2010. Vegetation Mitteleuropas mit den Alpen: in ökologischer, dynamischer und historischer Sicht. Ulmer Verlag, Stuttgart, Germany

Table S3. Characteristics of soil seed banks from two different sampling approaches. See methods section for further details. Soil moisture and nutrient supply have been calculated according to Ellenberg indicator values. LME indicates significant differences according to linear mixed-effects models with grassland as random factor (*** $p < 0.001$).

| | Autumn sampling | | | | LME | Spring sampling | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | | SD | Min/Max | | Mean | | SD | Min/Max |
| Species richness | 14.27 | ± | 5.38 | 1/28 | *** | 11.55 | ± | 4.62 | 1/22 |
| Seedling density ($m^2$) | 5107 | ± | 3427 | 102/16094 | *** | 3192 | ± | 2315 | 151/11582 |
| Seed weight | 0.77 | ± | 0.39 | 0.26/1.98 | | 0.73 | ± | 1.01 | 0.12/8.85 |
| Seed longevity | 0.5 | ± | 0.09 | 0.32/0.75 | *** | 0.54 | ± | 0.08 | 0.4/0.81 |
| Soil moisture indicator | 5.14 | ± | 0.42 | 4.16/6.49 | | 5.12 | ± | 0.45 | 4.0/5.99 |
| Nutrient supply indicator | 5.61 | ± | 0.72 | 3.59/7.29 | | 5.62 | ± | 0.98 | 3.17/7.67 |

Figures


Figure S1. Locations of the three study regions in Germany (modified after Klaus et al., 2011). See also Table S1 for environmental information of study regions.

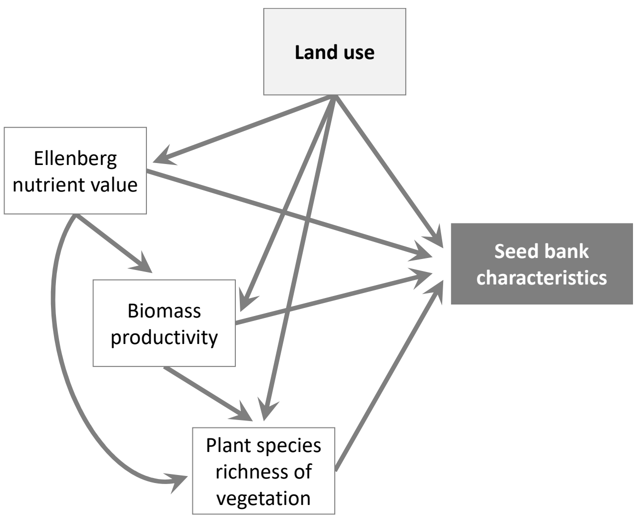


Figure S2. Full structural equation model of direct and indirect effects of land use on species richness and seedling densities of seed bank.

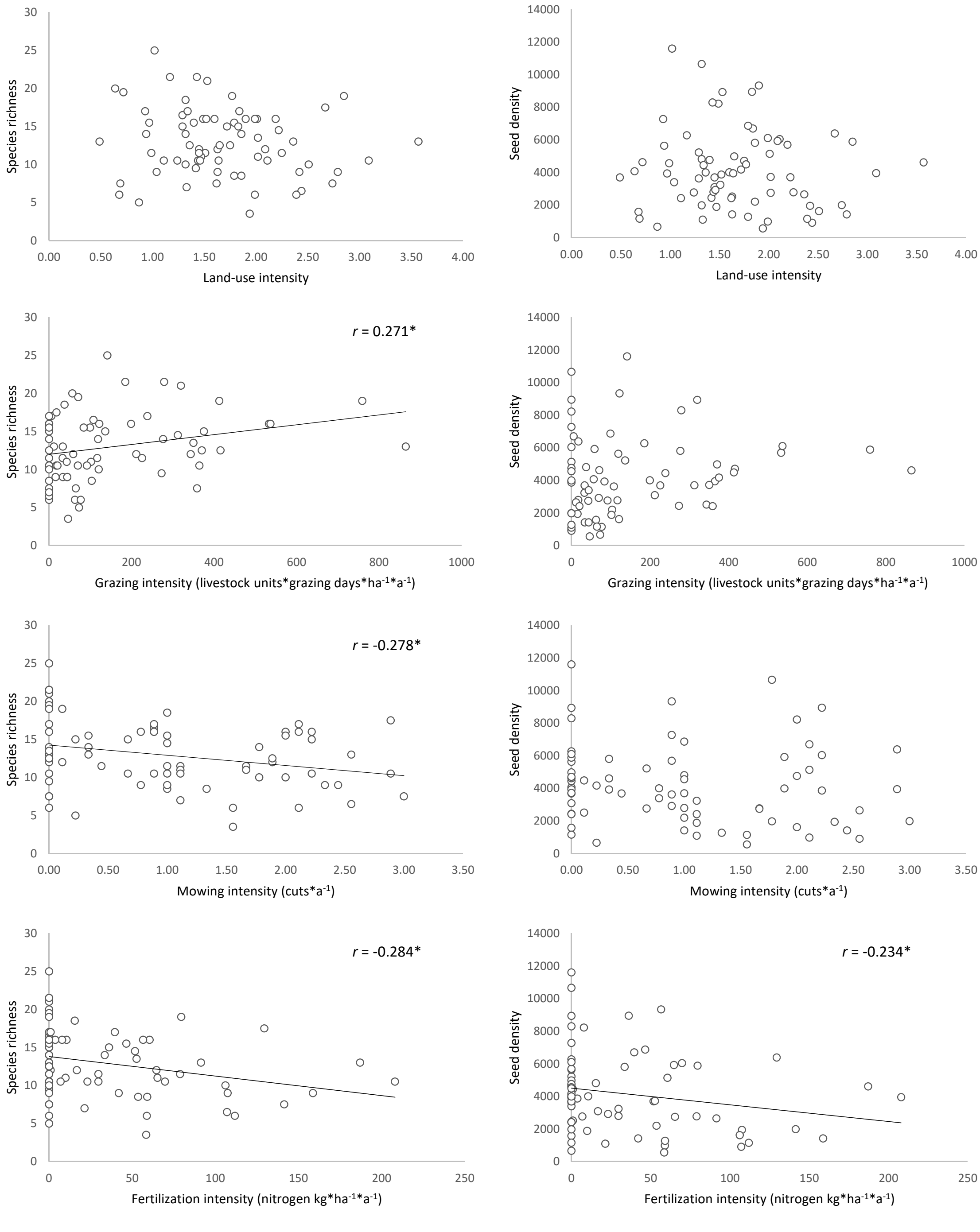


Figure S3. Species richness and seedling densities of soil seed banks in relation to land use. Only significant relationships shown (Spearman rho; significance level: * $p < 0.05$). Mean values for species richness and seedling densities calculated from both sampling approaches.

Reference:

Klaus, V. H., Kleinebecker, T., Hölzel, N. Blüthgen, N., Boch S., Müller, J., Socher, S. A., Prati, D., Fischer, M., 2011. Nutrient concentrations and fibre contents of plant community biomass reflect species richness patterns along a broad range of land-use intensities among agricultural grasslands. Persp. Plant Ecol. Evol. Sys. 13, 287–295.