Appendix I: Design of the Field Experiment

The **Field Experiment** involves a total of 240 subplots: 80 plots (size 1.5 x 3 m) of the Main Experiment (Roscher et al. 2004) with the three treatments described above (**Fig. 3**; see also **Fig. A1a**). The location in the plot is randomized. In addition, we set up monocultures from all species in the Jena Experiment species pool (60 species) on plots of 1 x 1 m, using the same soil preparation as in the treatment *'without plant history, without soil history'*; monoculture plots *'with plant history, with soil history'* are still available from the old set up in 2002. This resulted in two sets of monocultures (120 monocultures in total). We were not able to set up monocultures *'without plant history, with soil history'*, because the old monocultures were too small to further subdivide them into subplots. This limitation is being addressed by the complementary Ecotron Experiment.

For the *'without plant history, with soil history'* treatment in the Field Experiment, the upper 5 cm of soil were removed, and the underlying soil was homogenized and freed of large roots down to a depth of 30 cm (**Fig. A1**). Belowground plastic barriers (1.5 m long, 0-30 cm soil depth) were installed to avoid fast lateral colonization by soil organisms (**Fig. A1b**). For the *'without plant history, without soil history'* treatment, the upper 30 cm of the soil profile was exchanged by soil from an adjacent agricultural field site with similar conditions to those during the establishment of the Main Experiment in 2002 (~150 m^3 of soil in total). Both treatments were then sown with the plant communities according to the initial design of the Main Experiment (1000 germinable seeds/m^2; **Fig. A1c**; Roscher et al. 2004). Seed material was derived from a commercial seed supplier and therefore had no site-specific plant history. This experimental setup allows us to identify effects caused by soil biota (plant antagonists and plant growth facilitators). Soil nutrients and seed banks were not manipulated, but are measured to account for potential differences when comparing data for the 1- or 2-year-old new communities (2017, 2018, and so on) with data collected in years 2003, 2004, and so on for the now old communities.

All subprojects will perform their field sampling campaigns in concerted actions, such as shortly before the early summer harvest at peak plant biomass. Soil and plant samples will be shared to facilitate synthesis of the different assessments. In addition to plant community-level studies, we will employ a **phytometer approach** (e.g., Scherber et al. 2006, Eisenhauer et al. 2009, Lipowsky et al. 2011) to study plant species-specific eco-evolutionary responses to the experimental treatments in a standardized way (led by SP10). For this purpose, we selected a pool of eight plant species representing different functional groups (grasses, legumes, small herbs, and tall herbs) with two species per functional group (**Appendix III**). Specifically, this includes *Plantago lanceolata* and *Plantago media* as representatives of small herbs, *Geranium pratense* and *Ranunculus acris* as representatives of tall herbs*, Alopecurus pratensis* and *Trisetum flavescens* as representatives of grasses, and *Lotus corniculatus* and *Medicago x varia* as legumes*.* Phytometer species selected for the Field Experiment overlap in part with the Ecotron Experiment (**Appendix III**). In the Main Experiment (Roscher et al. 2004), which is the basis for the Field Experiment, these species occur on different numbers of plots (11-18 plots). Due to space limitations and because we do not want to disrupt plant communities in the target plot, we will grow not more than two of the selected phytometer species on a single plot that are part of the established target plots community. We tried to have each of the phytometer species in ten plots along the diversity gradient. Some species will have only eight or nine replicates though. Phytometers will be grown as offspring from seed families collected in the treatment *'with plant history, with soil history'*. We will grow phytometers from four seed families per source plot and will use three offspring per seed family to be planted in a target plot. The full design gives 75 plot-

species-combinations x 4 seed families x 3 offspring x 3 treatments = 2,700 plants). The design is flexible in various possibilities to reduce the number of studied plants for certain subproject-specific measurements. In addition to the study of 'selected' plants in the full design of the Field Experiment, transplant plants grown from the origin seed material (i.e., plants without selection history) will be grown in subplots *'with plant history and with soil history'*; i.e., among selected plants in their otherwise undisturbed communities. Therefore, mother plants have already been growing in the greenhouse in preparation of this proposal; the plants are growing well, and offspring will be transplanted to the Field Experiment.

In addition to the phytometer approach, **plant species-specific assessments** will be performed in collaborative studies using resident plant individuals. Twelve plant species were selected (three per plant functional group) that are sufficiently replicated in plots with low (1 and 2 species) and high plant diversity (8 and 16 species) and can thus be studied at the species-level in the treatment *'with plant history, with soil history'*. SP8 will measure plant defense traits on all twelve resident plant species, and SP11 will determine the genetic diversity. On three selected plants out of this pool (*Plantago lanceolata*, *Medicago x varia*, and *Trisetum flavescens*), SP7 will perform an herbivory experiment. Three individuals per plant species and plot will be infested with the generalist herbivore *Spodoptera littoralis* and three other plant individuals will serve as 'control plants' (without herbivory). On those six resident plant individuals per plot, SP7 will measure volatiles, and SP8 will intraspecific variability in shoot and root traits. Moreover, SP5 will measure community-level arthropod communities, predation and herbivory, and the response (arthropod communities, herbivory, and predation) to the intra-specific variability measured by the other SPs on all twelve resident plant species.

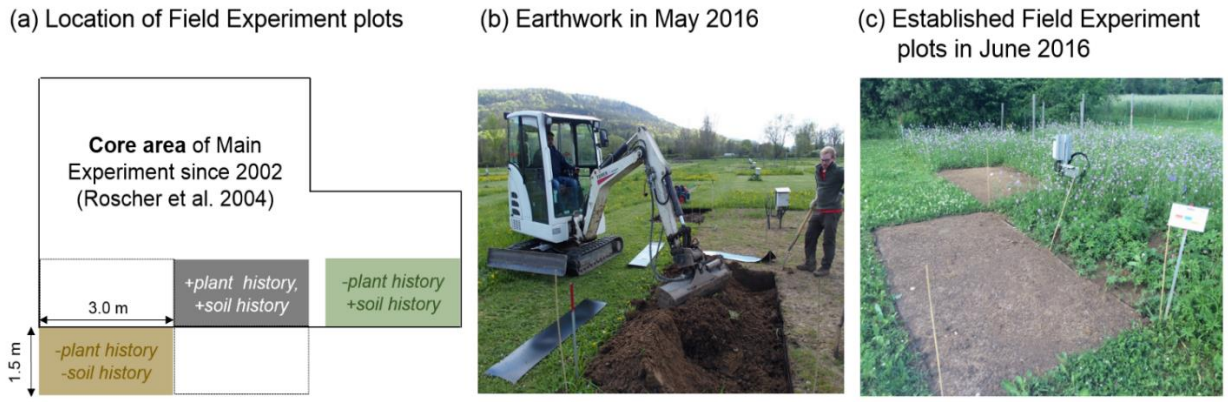

Figure A1. (a) *Spatial arrangement of the subplots of the Field Experiment in the plots of the Main Experiment (Roscher et al. 2004). The Field Experiment comprises three treatments: 'with plant history, with soil history', 'without plant history, with soil history', and 'without plant history, without soil history'. Locations of treatments per plot were randomized.* ***(b)*** *Photograph showing the earthwork and installation of belowground plastic barriers in May 2016.* ***(c)*** *Finalized plots shortly after sowing.*

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