



## **Establishment gaps as an innovative tool to restore landscape-scale grassland biodiversity**

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The large-scale abandonment of croplands resulted in landscape-scale changes in biodiversity, ecosystem services and agricultural production in Central Europe. Grasslands are vital landscape elements, and sustaining their biodiversity is crucial for biodiversity conservation. Thus, grassland restoration on former croplands offers a vital opportunity to restore grassland biodiversity. We studied vegetation changes in former croplands sown by grass seed mixtures in Hungary. We evaluated the usefulness of sowing grass seed mixtures, a frequently used restoration technique. We also developed a novel method (so-called establishment gaps) to increase the diversity of species-poor sown grasslands. We compiled a multi-species seed mixture containing 35 species. We established altogether 32 establishment gaps (size: 1×1-m, 2×2-m and 4×4-m) in 8-year-old restored grasslands. We evaluated the success and cost-effectiveness of spontaneous grassland recovery and active grassland restoration by seed sowing. We focused on the restoration of ecosystem services, like weed control, biomass production, and recovery of biodiversity. Using establishment gaps we could successfully introduce target species to the species-poor recovered grasslands. All sown species established in the establishment gaps and many of them maintained or even increased their first-year cover to the second year. Larger establishment gaps were characterised by higher cover of sown species and more homogeneous species composition compared to the smaller ones. Thus, we recommend using large establishment gaps in restoration practice. Our findings suggest that grassland restoration on croplands offer a viable solution for restoring biodiversity and ecosystem services. We found that both spontaneous grassland recovery and seed sowing can be cost-effective methods, and can be successful even during a relatively short period of a nature conservation project.