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Plant community composition promotes multiple ecosystem functions in grassland at low and high soil fertility

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It is well known that plant species richness can enhance primary productivity through complementarity in resource use by component plant species. Fewer studies have explored the role of plant species diversity and composition for the delivery of other ecosystem services than primary production and its dependency on resource availability. In this study we investigated how carbon (C) and nitrogen (N) stocks in vegetation, soil and soil microbes, the loss of C and N from soil through leaching and ecosystem exchange rates of CO2 are affected by the composition and richness of grassland plant communities and soil fertility. We used two soils of contrasting fertility in which we planted plant communities using a pool of six plant species from one of three functional groups (legumes, forbs and C3 grasses). The levels of plant species richness were one, two, three or six species and were composed of one, two or three functional groups. Soil fertility stimulated pools of C and N in shoots and roots, and the soil microbial biomass, but also increased significantly with increased plant functional group and plant species richness. Moreover, plant diversity suppressed N and water loss via soil leaching. We also found changes in the C and N content in soil, but these were not related to the richness of plant species or functional groups. The changes in soil were rather specifically due to the abundance of the legumes. The leaching of water and N was related negative to plant species richness but also specifically to the abundance of the forb species. Our findings show that the relation between plant community composition and storage of C and N in vegetation is not directly reflected in the changes in C and N storage in soil. These soil based storage functions, and the leaching of N from soil, appeared to be most strongly related to different key plant species. Together these results indicate that the maintenance of plant diversity is important to sustain the multiple functions grasslands provide.