

The economic value of species diversity in intensively managed grasslands

Schaub S.^{1,2}, Buchmann N.², Lüscher A.³ and Finger R.¹

¹*Agricultural Economics and Policy Group, ETH Zürich, Sonneggstr. 33, 8092 Zürich, Switzerland;*

²*Grassland Sciences, ETH Zürich, Universitätstr. 2, 8092 Zürich, Switzerland;* ³*Forage Production and Grassland Systems, Agroscope, Reckenholzstr. 191, 8046 Zürich, Switzerland*

Introduction: Species diversity (D) in grasslands can affect biomass yield and its quality in terms of both expected outcomes and their variability, i.e. production risk. For farmers, all these components are economically relevant. However, they have not been broadly addressed in previous agricultural economic studies. We contribute to filling this gap and quantify the D effects on grassland yields and quality using field trial data from intensive grassland production throughout Europe. We economically evaluate the D effects on grassland production and value it in terms of farmers' utility.

Data and methods: We used biomass yield, quality and D (Simpson Index) data from 16 intensively managed grassland experiments across Europe, each with 30 plots of varying D (richness and evenness; Kirwan *et al.*, 2014). First, employing a stochastic production function approach (Finger and Buchmann 2015), we estimated the D effects on three expected outcomes: biomass yield (kg forage yield ha⁻¹), milk production potential (MPP; kg milk kg⁻¹ forage) and MPP yield (kg milk ha⁻¹) and their variances. Second, we used the expected utility framework to economically value farmers' utility gain from D. For this, we monetized the outcomes using potential milk sale revenues ($\pi = \text{MPP yield milk price}$) and computed the certainty equivalent for risk averse farmers.

Results: Species diversity of the reference mixture (the equiproportional four species mixture) increased biomass yield by ~30% and decreased its variance by ~50%, while it had no effect on MPP (Table 1). Thus, D increased MPP yield (~30%) and decreased its variance (~45%). The certainty equivalent increased with D, e.g. by ~35% for the reference mixture compared to the monocultures.

Table 1. D effects on expected outcomes and their variances for the reference mixture.¹

	Biomass yield (kg ha ⁻¹)	MPP (kg kg ⁻¹)	MPP yield (kg ha ⁻¹)
Expected outcome			
Species diversity	+30%***	-1% ^s	+29%***
R^2_{adj}	0.77	0.47	0.79
Variance of outcome			
Species diversity	-51%**	-76% ^{ns}	-47%*
R^2_{adj}	0.16	0.03	0.16

¹ ns = not significant; * $P < 0.1$; ** $P < 0.05$; *** $P < 0.01$.

Conclusion: Our results show that farmers can attain positive economic benefits from D in intensively managed grasslands. Consequently, D can contribute to sustainable intensification of grassland-based production.

Finger R. and Buchmann N. (2015) An ecological economic assessment of risk-reducing effects of species diversity in managed grasslands. *Ecological Economics* 110, 89-97.

Kirwan L., Connolly J., Brophy C., Baadshaug O. H., Belanger G., Black A., ... Finn J. (2014) The Agrodiversity Experiment: three years of data from a multisite study in intensively managed grasslands. *Ecology* 95, 2680. <https://doi.org/10.1890/14-0170.1>