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Land-use effects on plant and arthropod diversity in South African savannahs

KAI BEHN¹, BIANCA GREYVENSTEIN², FRANCES SIEBERT², JOHNNIE VAN DEN BERG², VINCENT MOKOKA³, CATRIN WESTPHAL⁴, SARA YAZDAN-BAKHSH⁵, JAN-HENNING FEIL⁶, STEFAN FOORD⁷, INGO GRASS⁸, REIMUND P. RÖTTER⁴, PETER TAYLOR⁹, ANJA LINSTÄDTER¹⁰

¹University of Bonn, Inst. Crop Sci. and Res. Conserv. (INRES) - Plant Nutrition, Germany

²NorthWest University, School of Biological Sciences, South Africa

³University of Pretoria, Dept. of Geography, Geoinformatics and Meteo., South Africa

⁴University of Göttingen, Dept. of Crop Sciences, Germany

⁵University of Göttingen, Dept. of Agricultural Economics and Rural Development, Germany

⁶South Westphalia University of Applied Sciences, Agricultural Economics and Digital Farm Management, Germany

⁷University of Venda, SARChi Chair on Biodiversity Value and Change, South Africa

⁸University of Hohenheim, Inst. of Agric. Sci. in the Tropics (Hans-Ruthenberg-Institute), Germany

⁹University of the Free State, Zoology and Entomology Department and Afromontane Research Unit, South Africa

¹⁰University of Potsdam, Inst. of Biochemistry and Biology, Biodiversity Research / Syst. Botany, Germany

Abstract

Savannah ecosystems in southern Africa are biodiversity hotspots and are highly important for various ecosystem services. They are increasingly threatened by land-use intensification, with mostly negative consequences on biodiversity. Along the intensification pathway, near-natural savannahs are typically first converted into rangelands, then into croplands, and finally into intensively used homegardens. However, land-use intensity in croplands and homegardens also depends on the farmer's socio-economic background. Thus, our study addresses the following questions: (1) How does land-use intensification affect the taxonomic and functional composition, and diversity of plant and arthropod communities? (2) Do farmers' socio-economic background play a role in this context?

We conducted our study in South Africa's Limpopo province. Climate is semi-arid, and natural vegetation is a thornbush savannah. We sampled in four land-use types along the intensification pathway, i.e. a game reserve with near-natural vegetation, communal rangeland, cropland, and homegardens. Plot selection in cropland and homegardens was stratified into four socio-economic classes based on household surveys. Field assessments of vascular plants and arthropods (via pan and pitfall traps) were conducted in the vegetation period 2020/21. To assess and compare diversity, we performed PERMANOVA, and calculated Shannon- and association indices.

We found that plant and arthropod communities differed strongly across land-use types. Many species were only recorded in one type, and the dominances of functional groups varied. The game reserve was dominated by native, perennial grasses with high forage value.

In the rangelands, they were replaced by annual grasses. Annual forbs, many of them introduced species, were common in the croplands and home gardens. For arthropods, similar patterns were observable, with agricultural pest species restricted to croplands. Farmers' socio-economic background influenced diversity in homegardens, with richer households had lower arthropod diversity.

Land-use intensification in the savannah biome increased overall diversity of plants and arthropods. However, many native wild species were lost outside of the protected area, among them valuable forage grasses. Protected areas are therefore of critical importance for biodiversity conservation, as they can act as refuge for useful wild plants and beneficial arthropods. Education of farmers on beneficial arthropods may further help to reduce losses in these species groups.

Keywords: Beneficial arthropods, biodiversity, ecosystem functions, game reserve, home gardens, Limpopo, rangeland, smallholder farmers, vegetation