Effects of organic farming on ecosystem services and multifunctionality in Switzerland: the *ServiceGrass* project

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Abstract

Sustainable agriculture delivers not only market goods but also many public ecosystem services and non-market goods. Agricultural intensification undermines the delivery of many public ecosystem services at local level. Organic farming might decrease the environmental impact of intensive food and feed production on grasslands and could therefore be able to sustain both private and public ecosystem services. A systematic literature search of scientific publications revealed the absence of literature on the impact of organic farming on ecosystem services in grasslands. Thus, the project *ServiceGrass* was initiated to explore effects of organic grassland farming on several ecosystem services and their simultaneous provisioning, i.e. multifunctionality, in Switzerland. The principal aim of the project is to compare the ability of organic and conventional grasslands to deliver ecosystem services at plot and farm levels, including management intensification as a major driver. We aim at up-scaling results from grassland plots to farm- and sector-level in order to draw conclusions on the realized ecosystem services portfolio of both farming systems. Findings of this project will underline strengths and weaknesses of organic and conventional farming systems in delivering multiple ecosystem services for sustainable future grassland management.

Keywords: environmental impacts, economic assessment, grassland management, intensification, multifunctionality, sustainable agriculture

Introduction

Ecosystem services (ES) are the many indispensable benefits that humans gain from properly functioning ecosystems. Agricultural systems such as grasslands are supposed to deliver not only private ES, i.e. market goods, but also many public ES, i.e. non-market goods and services relevant for long-term food security and sustainable development. Given a growing world population and an increasing demand for meat and milk, understanding and managing the delivery of ES is of vast importance for human well-being (MEA, 2005; UN, 2015).

Grasslands are expected to provide an outstandingly high number of different ES, but quantitative measurements of many services are scarce (Allan *et al.*, 2015). In addition, the ongoing intensification of grassland management is the most important change affecting ES provision (Tscharntke *et al.*, 2005), mostly by increasing private services (forage yield and forage quality) but decreasing public services (Allan *et al.*, 2015). Thus, there are important trade-offs between individual ES and a sustainable intensification of food and feed production that increases productivity but maintains high levels of multifunctionality, i.e. the provision of multiple ES at once, is a major agricultural challenge. Organic farming is said to be among the most relevant strategies to decrease environmental impacts of intensive food and feed production (Reganold and Wachter, 2016), which in turn is assumed to maintain high levels of public ES (Sandhu *et al.*, 2010). Still, the environmental impact of intensification often differs when related to unit of land use area or to unit output (Jan *et al.*, 2019). It can be hypothesized that organic management of grasslands could be especially promising to promote multifunctionality because yields remain reasonably high under organic management (Klaus *et al.*, 2013). However, this has never been assessed.

Materials and methods

We assessed the published scientific literature on effects of organic farming with regard to ES and multifunctionality in grasslands to identify the number of publications on these topics. We screened existing literature via a systematic literature search using the search string ['organic* farm*' OR 'organic* manage*' OR 'organic* prod*'] AND [grassland* OR pastur* OR 'meadow*' OR 'hayfield*' OR rangeland* OR 'graz* land*'] as well as the same search plus AND 'ecosystem service*'. We then replaced 'ecosystem service*' with [multi-functionality OR multifunc* OR 'multi functionality']. We reran the search string with replacing the previous grassland search string with either ['permanent grassland*' OR meadow*] or ['temporary grassland*' OR ley*] to assess results for both grassland types separately. We used the number of publications found as an indicator of how well different aspects of organic grassland management have been studied. To compare the amount of literature published on grasslands with that from croplands, we reran all searches with ['arable land*' OR cropland* OR 'crop* rotation*' OR 'crop* syst*'] instead of the grassland strings. The search was done on 29 October 2019 using the *Web of Science* database from Clarivate searching in titles, abstracts, keywords in all publication entries of the Web of Science Core Collection from 1900 to 2019.

Results and discussion

The systematic literature search revealed considerably fewer scientific publications on organic farming in grasslands than on croplands (Figure 1). Searching specifically for temporary and permanent grasslands revealed particularly few results (Figure 1A). Concerning ES provision, only two studies addressing organically farmed permanent grasslands could be identified (Figure 1B). Studies on multifunctionality were generally very scarce and only when the search terms 'grassland' or 'cropland' were omitted could a significant number of studies be identified (Figure 1C). This suggests that currently, ES multifunctionality

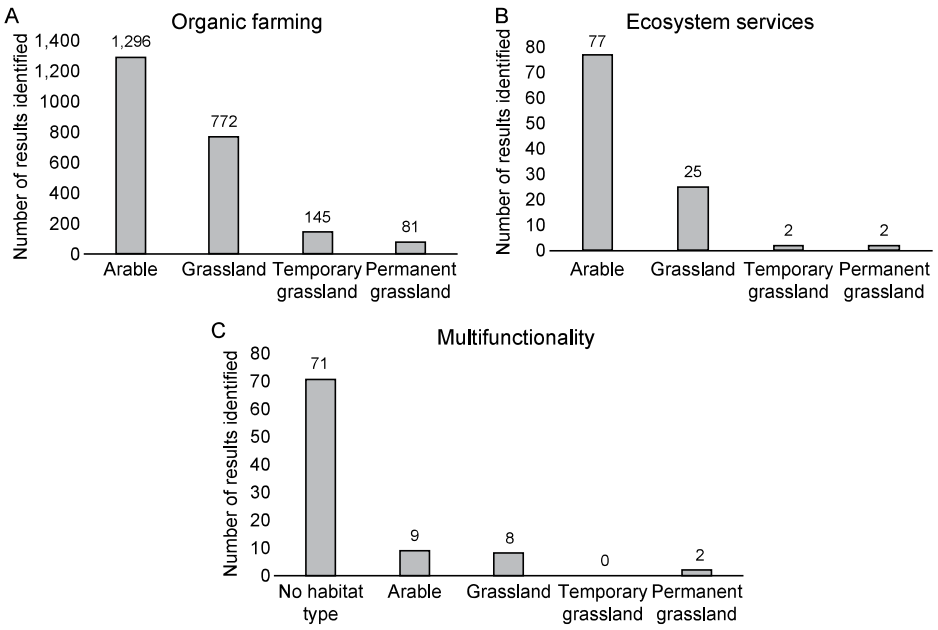

Figure 1. Outcomes of the systematic literature search comparing the number of scientific publications found on organic farming in croplands and grasslands. The latter was further separated into temporary grasslands (leys) and permanent grasslands. Panels show the number of (A) scientific publications in general, (B) publications including ecosystem services and (C) publications including multifunctionality. See methods section for details.

with regard to organic farming is rather a conceptual idea, and that evidence from published literature is scarce. However, it is possible that studies assessed more than one function but did not use the term 'multifunctionality' in the paper. In such cases, we would have underestimated the number of studies published. Despite the economic importance of grasslands, their high proportion of land cover, their potential multifunctionality and their biodiversity (Allan *et al.*, 2015; Le Clec'h *et al.*, 2019), a comprehensive assessment of ES and of the multifunctionality of organically managed grasslands has obviously never been made. The project *ServiceGrass* started in 2019 and aims at closing this knowledge gap. Its principal aims are (1) to measure and compare ES in organic and conventional grasslands in Switzerland, (2) to explain the impact of intensification on multifunctionality, and (3) to upscale plot-level results to farm- and sector-level. For the latter, we will combine measurements of ES from on-farm grassland plots with technical, structural and economic data from face-to-face interviews with Swiss farmers, farm accountancy and census data. This will enable us to draw conclusions on the effects of different management practices, as revealed by the farmers' interviews, on the delivery of grassland ESs. Project outcomes will be of high agricultural and societal relevance, as they will assess the effectiveness of grassland-based farming systems in ES provision and help improving organic and conventional farming systems to promote multifunctionality.

Conclusions

Effects of organic farming of grasslands, especially with regard to ES and multifunctionality, are widely under-studied, although grassland depicts the major share of land under organic management worldwide. To close this gap, the project *ServiceGrass* will intensively assess and evaluate ES provision from conventional and organic grasslands in Switzerland to promote the sustainable development of grassland management.

Acknowledgements

We thank the Mercator Foundation Switzerland and the Fondation Sur-la-Croix for funding the *ServiceGrass* project. NEB and NB received funding from the European Union Horizon 2020 Research and Innovation programme, Grant Agreement 774124 (SUPER-G).

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