Rainfall regulation of grazed grasslands

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Grazing is a major land use activity in grasslands of arid and semiarid regions. As a result, addressing how large herbivore grazing affects biodiversity and ecosystem functions in these ecosystems has been diligently studied by ecologists for many decades (1). In PNAS, Wang et al. (2) suggest that diversifying livestock (i.e., grazing sheep and cattle rather than a single type of livestock) could promote biodiversity and ecosystem function in grasslands, which may significantly enhance northern grassland restoration in China. This is because single-type livestock grazing has become more prevalent recently, compared to historical use, which may be related to extensive degradation of grasslands. However, Wang et al. (2) do not consider precipitation effects as an independent factor, or coupled with the effects of grazing. We see this as a major omission for a paper purporting to investigate key drivers of semiarid grassland dynamics, as the importance of precipitation variability, particularly in grazing lands, is increasing globally (3).

Studies indicate that grazing effects on plant species composition and ecosystem functions in grasslands are primarily dependent on rainfall (1, 4–7). For example, herbivores can enhance plant biodiversity at high productivity but decrease it at low productivity (the "precipitation" gradient generally has been recognized as "productivity") (1). Grazing-induced reductions of ecosystem functions also are larger in dry sites than in wet sites both on the Mongolia Plateau and in Australia rangelands (4, 5). In North American rangelands, climatic factors control major trends in plant species composition and production, with grazing playing a secondary role (6). Our previous work in a semiarid grassland demonstrates that the effect of interannual variation in rainfall on plant species richness was ∼4 times that of the grazing intensity, and a deficiency of rainfall can amplify grazing damage on biodiversity and ecosystem function (7).

Climate effects can also mainly direct relationships between biodiversity and ecosystem multifunctionality (EMF) in drylands (8–10). For example, Jing et al. (8) found that climate variation (i.e., mean annual precipitation) can modify or determine the effects of biodiversity (both aboveground and belowground) on EMF in Tibet Plateau grasslands. Moreover, climate (i.e., aridity = precipitation/potential evapotranspiration) significantly mediates EMF via altering plant attributes in drylands worldwide (9). Lastly, the relationships between biodiversity and EMF also have been consistently changed by the environmental gradients (10).

Wang et al. (2) suggest that livestock diversification increases ecosystem multifunctionality by increasing biodiversity. However, they omit exploring how this mechanism might be driven by rainfall effects. We appreciate the effort of the authors in exploring relationships between grazing and plant community dynamics. However, omission of precipitation effects in a study of arid or semiarid rangelands limits our ability to develop a comprehensive understanding of the ecology of the system. We strongly support the inclusion of precipitation factors, in some form, in all analyses that attempt to uncover drivers of plant characteristics in these grazed landscapes.

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