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Management Options for Sustainable Land-Use of Inner Mongolia Typical Steppe: Lessons from a Comprehensive N Balance

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Abstract

Inner Mongolian semi-arid grasslands are substantially affected by land degradation as a consequence of excessive overgrazing during the last decades. Nitrogen (N) is considered as a key element for ecosystem functions and therefore of fundamental importance to maintain forage production.

N pathways of Chinese typical steppe were quantified at sites representing different land-use practices including heavy grazing (HG) and haymaking.

Results showed that grassland NPP requires 3–7 g N m⁻² yr⁻¹, which is mainly provided by N mineralisation from the large soil organic matter pool. Our N balances indicated that HG must be considered as N source with annual total net losses of up to 1.7 g N m⁻², mainly due to dust emissions and excrement export, the latter resulting from keeping sheep in folds overnight. Soil N mining by HG was indicated by reduced pool sizes of both topsoil organic N, and above- and belowground biomass N. Haymaking contributed to substantial annual N losses (up to 1.4 g N m⁻²), but sites were not affected by wind erosion and thus balanced with regard to N gains and losses.

Management options in terms of a sustainable N balance could include sheep excrements redistribution to grazing areas with a potential to decrease up to 70% of annual N loss related to animal feed intake. N losses due to export of live weight and wool were relatively small and could be sustainable as soon as stocking rates are reduced to a level at which remaining biomass prevents wind erosion. The establishment of haymaking sites ameliorated by e.g. the cultivation of legumes may improve regional N balances. Small amounts of mineral N fertiliser can further contribute to a sustainable land-use with regard to the N balance and forage production. Most N-related processes were more intensive in seasons of higher water availability indicating complex interactions between land-use intensity and climate variability.

Land use practice (e.g. pastoralists in context of socio-economic systems) will be increasingly important for the management of N dynamics in Chinese typical steppe and, therefore, must be considered as a key component to maintain and optimise ecosystem services.

Keywords: Grazing, N-balance, semi-arid grassland