Management options for sustainable land-use of Inner Mongolia typical steppe – lessons from a comprehensive N balance

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Background

- Overgrazing and land degradation affects large areas of Inner Mongolia grasslands.
- To identify key N-processes as affected by grazing is crucial to maintain, improve or restore ecosystem services.

Results

- The ungrazed site was a N sink with annual net N input of up to 2.9 g N m^{-2} mainly by dust deposition.
- The heavy grazed site was a N source with annual losses of up to 1.7 g N m^{-2}. Dust emissions and excrement export to sheep folds were main pathways.
- Haymaking contributed to substantial annual N losses (up to 1.3 g N m^{-2}).
- N losses due to export of live weight and wool were relatively small.

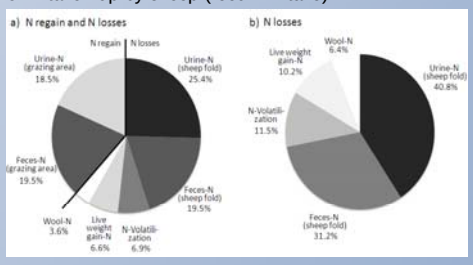
Management options

- Redistribution of sheep excrements to grazing areas with a potential to decrease N losses up to 70% based on animal feed-N intake.
- Reduce stocking rates to a level which prevents wind/water erosion.
- Establishment of haymaking sites ameliorated by e.g. the cultivation of legumes and low fertilizer supply.
- Increasing atmospheric N input (up to 5 g m^{-2}) may compensate for N losses induced by grazing.
- Grazing / hay production as a management tool to extract N from grasslands (reduce eutrophication).

Conclusions

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.

Pathways (N losses and regain to grazing area) of N taken up by sheep (feed-N intake).



Dung heaps: Sheep dung collected from sheep folds is piled for drying and used for heating and cooking.

About 50% of excrements are lost from grazing areas and dropped to folds where sheep are kept over-night.

Hay is used for supplemental fodder during winter which causes considerable N losses from grasslands.

Annual N gains and losses of typical Inner Mongolia Steppe under different land-use intensities.

Components of N balance (g N m^{-2} yr^{-1})	Long term heavy grazing	Winter grazing/ hay production	Long term grazing excl.
N-gains			
Net dust deposition	-	0.3 (± 0.2)	1.2 (± 0.8)
Wet deposition	0.6 (± 0.2)	0.6 (±0.2)	0.6 (±0.2)
N_2-fixation	0.05 (± 0.03)	0.05 (± 0.03)	0.05 (± 0.03)
N-losses			
Net dust emission	0.4 (± 0.4)	-	-
N_2O emissions	0.01 (± 0.006)	0.01 (± 0.006)	0.02 (± 0.005)
NO_x emissions	0.03 (± 0.006)	0.03 (± 0.006)	0.03 (± 0.006)
Denitrification (N_2 losses)	0.01 (± 0.006)	0.01 (± 0.006)	0.02 (± 0.005)
NH_3 emissions (from urine patches)	0.09 (± 0.02)	0.001	0
Capillary rise, leaching	± 0	± 0	± 0
Wet deposition surface runoff	0.06 (± 0.02)	± 0	± 0
Organic N-loss (by water and wind)	0.3 (± 0.1)	± 0	± 0
Excrement export to folds (urine, dung)	0.57	0.06	0
Sheep live weight export	0.08	0	0
Sheep wool export	0.05	0.02	0
Hay production (~ 60% of ANPP)	0	~ 1.13 (± 0.15)	0
Total balance	**-0.9** (± 0.8)	**-0.3** (± 0.6)	**1.8** (± 1.1)

Ranges represent seasonal variations of N balance components.

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