Effect of grazing intensities on photosynthetic carbon allocation in a temperate grassland

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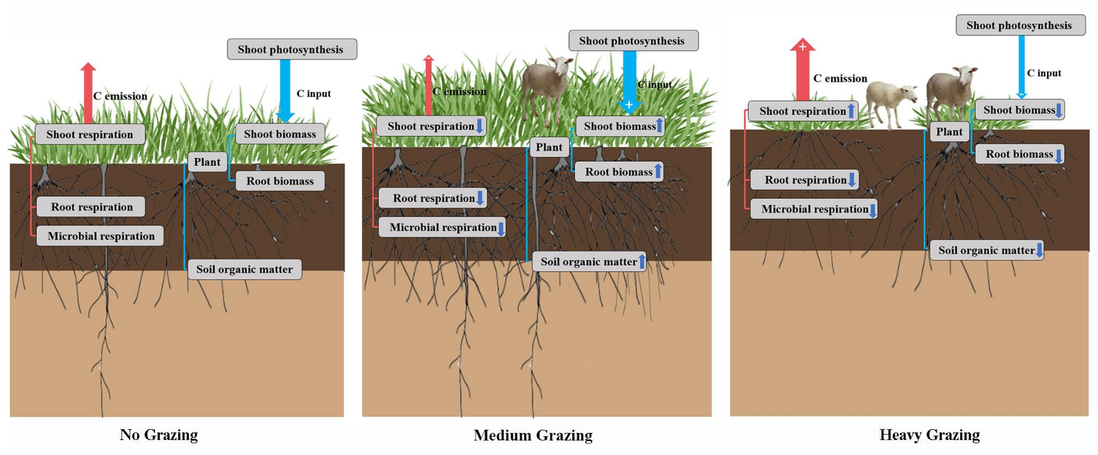
Introduction

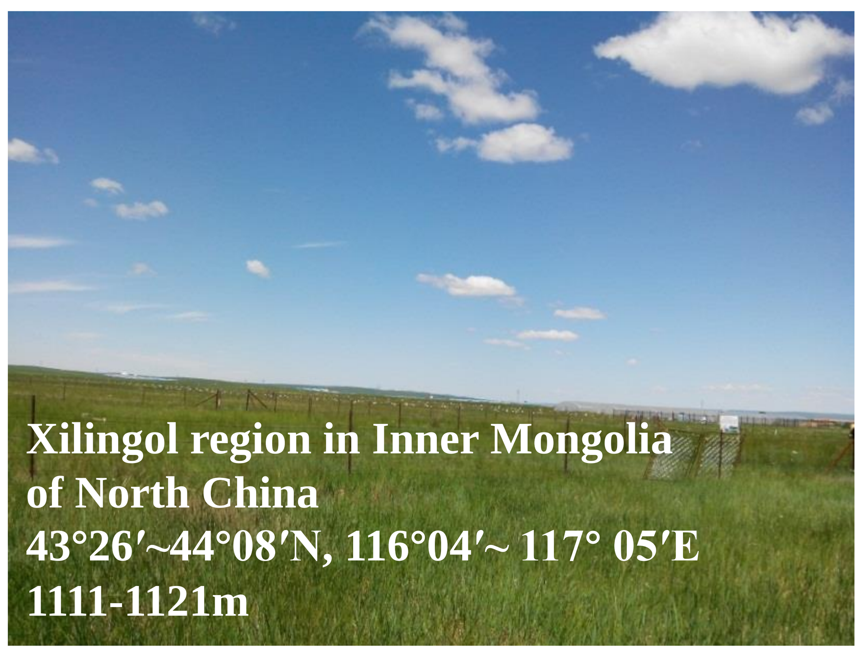


Problem: It still remains unclear how different grazing intensities effect on recently-photosynthetic C distribution in ecosystems.

- In temperate grasslands of North China, animal husbandry represents the traditional land use.
- The rapid increase in livestock during recent decades raised concern about the ongoing ecological and environmental impacts.

Materials and methods

Study site



Climate
temperate continental climate

Annual average temperature
2.6℃

Annual precipitation
271.42mm

Soil type
chestnut soil

Dominant plant species:
Stipa grandis, *Leymus chinensis*

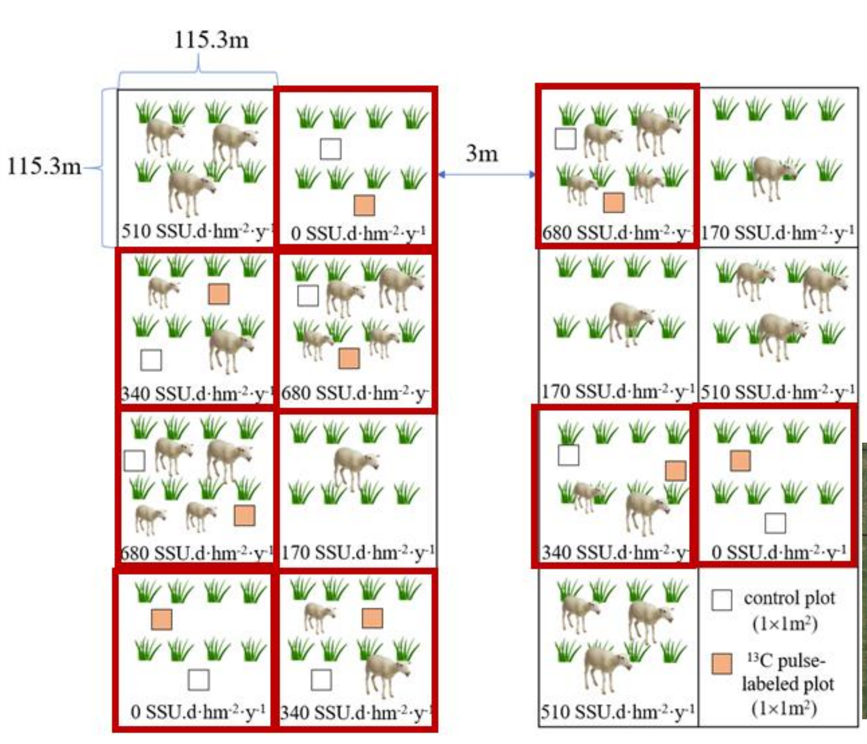
Experimental design

No Grazing (0 SSU.d hm^{-2} y^{-1})

Medium Grazing (340 SSU.d hm^{-2} y^{-1})

Heavy Grazing (680 SSU.d hm^{-2} y^{-1})

- During 2007-2014 years, the experimental areas were banned from grazing. Three different grazing intensities were implemented on 10 June 2014 and lasted for 90 days. Each grazing area is 1.33 hectares.



^{13}C labeling

Static alkali absorption

Li-8100

Calculation

- $$^{13}C_{atom\%excess} = atom\%_{labeled} - atom\%_{unlabeled}$$

Stable isotope ^{13}C calculation. $^{13}C_{atom\ \%\ excess}$ of total C atoms was calculated by atom percent of labeled samples (atom% $_{labeled}$) subtracting atom percent of unlabeled samples (atom% $_{unlabeled}$).

- $$^{13}C = C_{stock} \times 13C_{atom\%excess} \times \frac{13}{atom\%\times13+(100-atom\%)\times12} \times 10^3$$

$$^{13}C_{rec} = \frac{^{13}C_t}{^{13}C_{t1}} \times 100$$

where the $^{13}C_t$ (mg ^{13}C m^{-2}) represents the amount of ^{13}C in different stocks at time t after the labeling, and the $^{13}C_{t1}$ (mg ^{13}C m^{-2}) represents the amount of ^{13}C entering the grassland on the first day.

Results

^{13}C dynamics in the plant–soil system

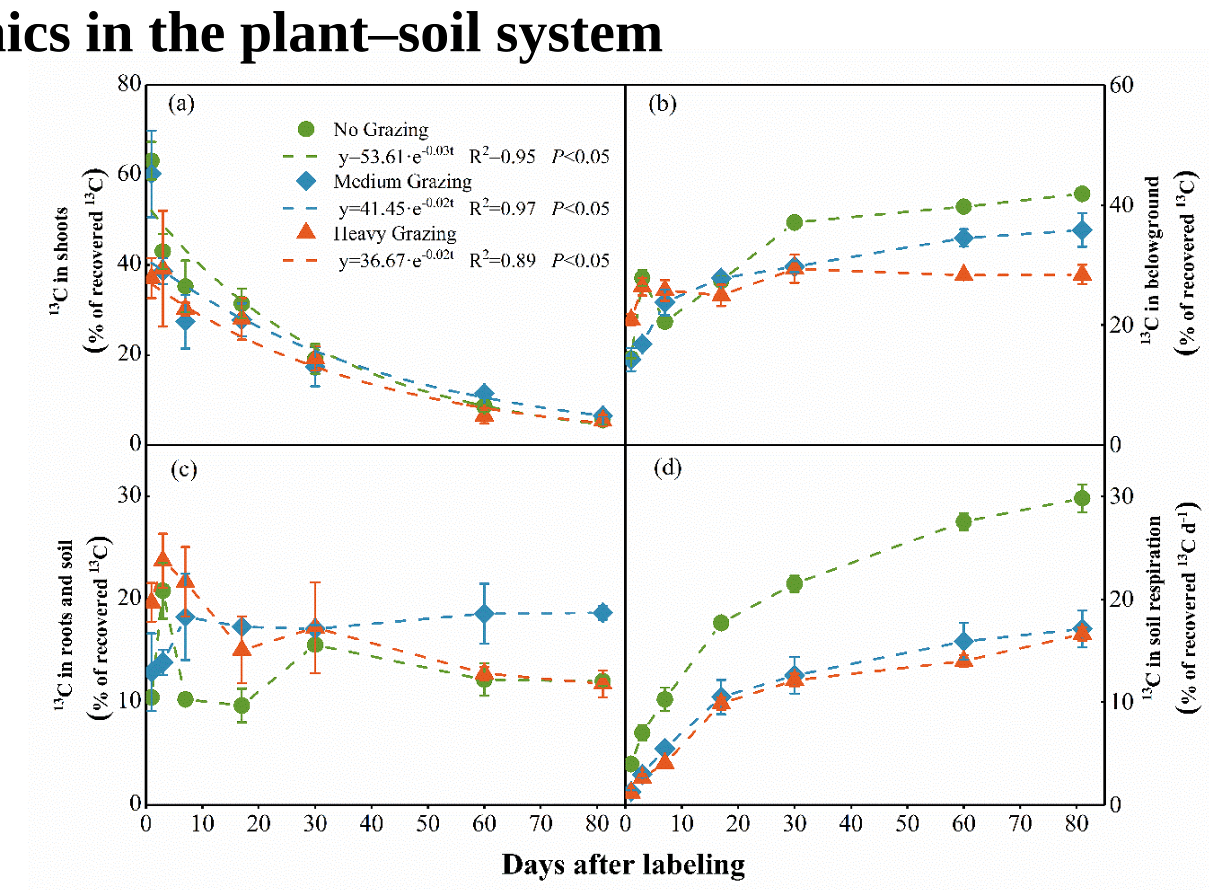


Fig.1 ^{13}C allocation to (a) shoots, (b)belowground(roots, soil and soil respiration), (c) roots and soil and (d) soil(roots and microorganism) respiration during the chase phase after labeling under three grazing intensities.

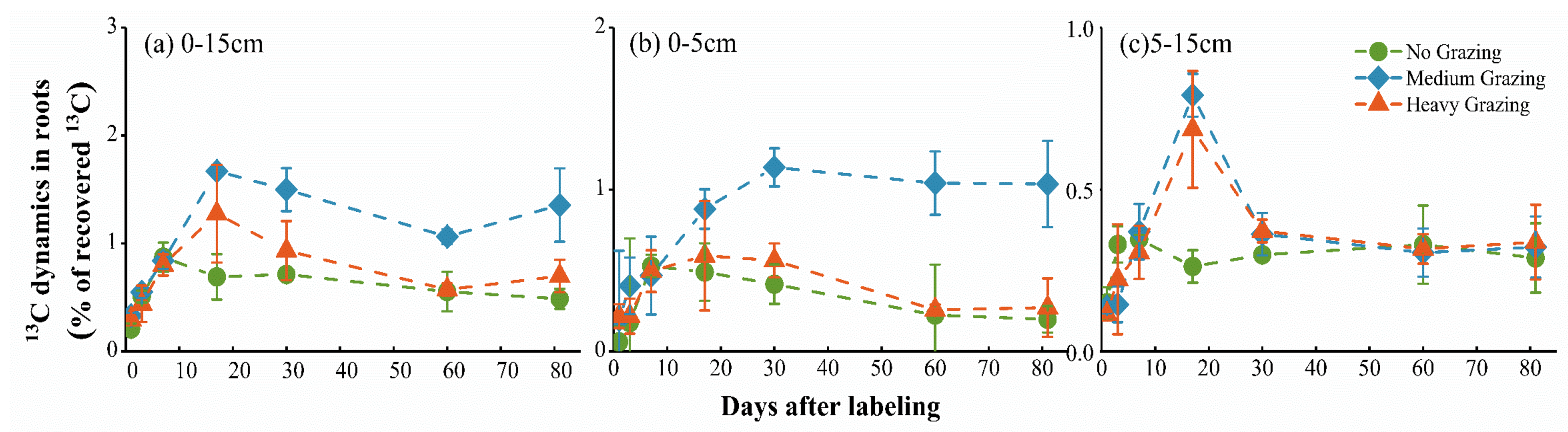


Fig.2 ^{13}C dynamics in roots

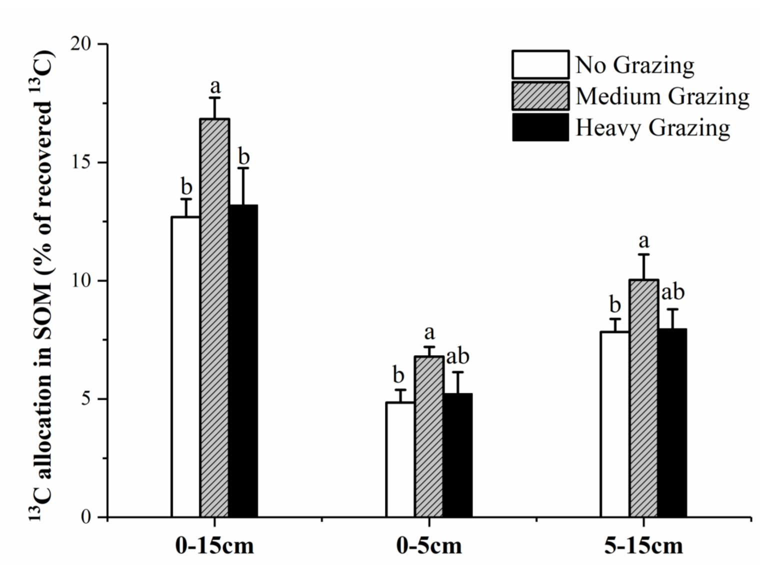


Fig.3 ^{13}C allocation in Soil Organic Matter (SOM)

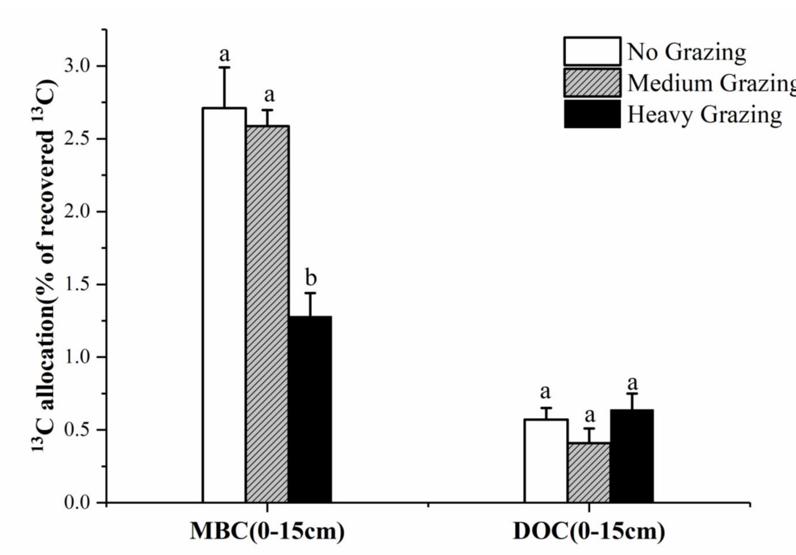


Fig.4 ^{13}C allocation to Dissolved Organic Carbon(DOC) and Microbial Biomass Carbon(MBC)

Contribution of assimilates to CO_2 efflux from soil and CO_2 sources

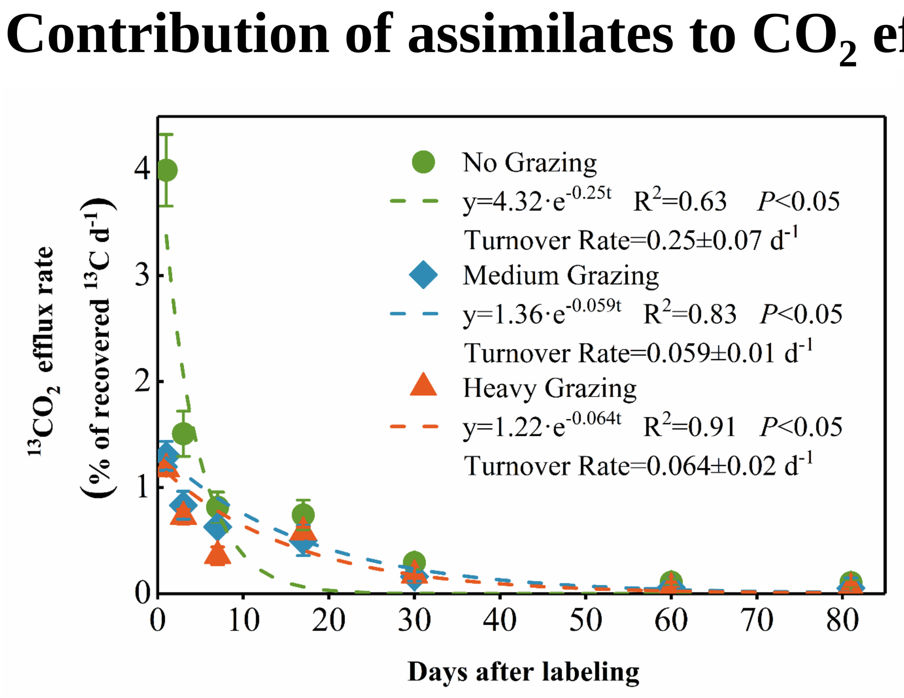


Fig.5 $^{13}CO_2$ efflux rate of soil respiration of the three grazing intensities, curve fitted by first-order kinetics and calculated turnover rates of non-structural C used for root and rhizomicrobial respiration.

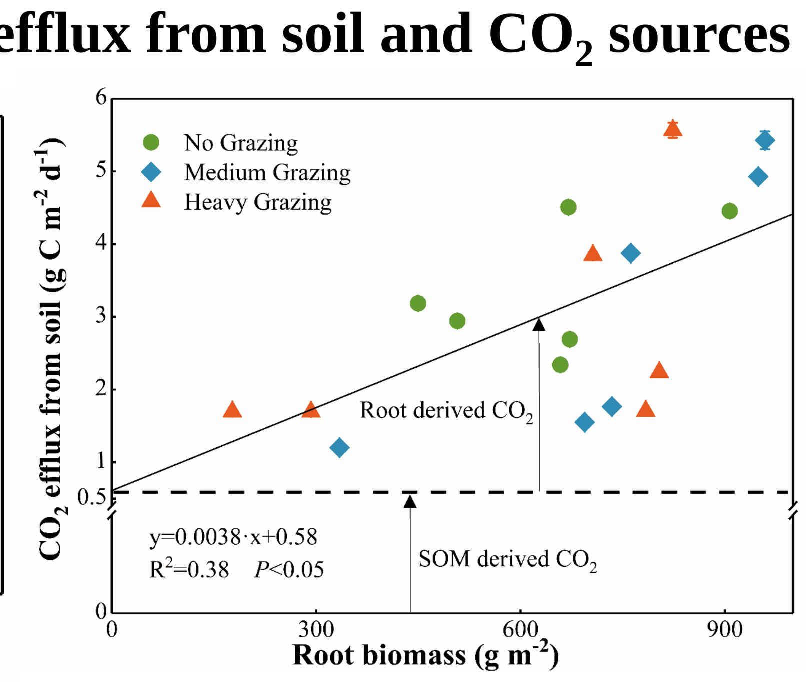
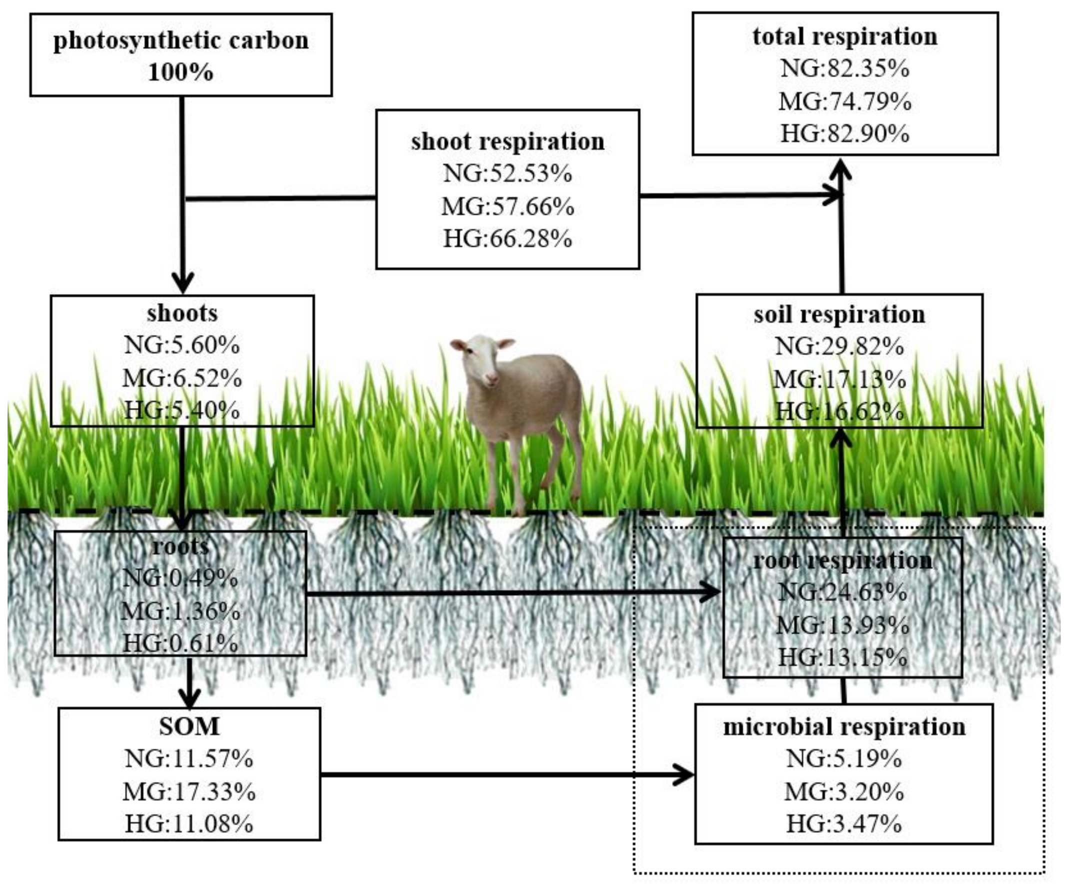


Fig.6 Linear regression between root biomass and total CO_2 efflux from soil for the three grazing intensities plots. Arrows indicate the portion of SOM derived CO_2 and root derived CO_2.

Conclusion



- We conclude that the no grazing and heavy grazing leads the decrease of C sequestration and medium grazing is the most suitable grazing intensity to maintain the carbon sequestration capacity of grassland ecosystems.
- ^{13}C labeling experiments demonstrated medium grazing increased SOM assimilates.