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Theme 5. Environmental issues related to grassland
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Importance of grassland management for carbon sequestration and to mitigate climate change: A review

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Introduction

Grasslands, including rangelands, shrub lands, pastureland, and cropland sown with pasture and fodder crops, covered approximately 3.5 billion ha in 2000, representing 26 percent of the world land area and 70 percent of the world agricultural area, and containing about 20 percent of the world's soil carbon stocks (Ramankutty *et al.*, 2008). All ecosystems- forested ecosystems, agro-ecosystems, grassland, ecosystems etc. take up atmospheric CO2 and mineral nutrients and transform them into organic products In undisturbed ecosystems, the carbon balance tends to be positive: carbon uptake through photosynthesis exceeds losses from respiration, even in mature, old-growth forest ecosystems.

Improving cropland and grassland management is key to increasing crop productivity without further degrading soil and water resources. At the same time, sustainable agriculture has the potential to deliver co-benefits in the form of reduced GHG emissions and increased carbon sequestration, therefore contributing to climate change mitigation.

Materials and Methods

Sequestration is the process of storing carbon in a carbon pool. Many methods are suggested for its quantitative measurements at various levels. The best nondestructive way to measure the amount of carbon sequestered by plants is measure the biomass of the plants. This can be done through estimating allometric relationships between something that is easily measured non-destructively (basal diameter of stem, etc.) and the biomass of the plant. Another way is measuring net ecosystem exchange of carbon (NEE) is possible using eddy co-variance techniques but this includes soil decomposition, not just plant sequestration. Photosynthetic rate measurement is also a good parameter to estimate the carbon sequestering by plants. The device can be installed in a little representative portion of the field and can be extrapolate to the rest of it. Infra-red gas analyzer (IRGA) is also widely used to measure net CO_2 uptake usually on individual leaves. Snapshots can be taken for estimating the sequestration through flux measurements.

Results and Discussion

Like carbon sequestration in forests or agricultural land, sequestration in grassland systems – primarily, but not entirely in the soils – is brought about by increasing carbon inputs. It is widely accepted that continuous excessive grazing is detrimental to plant communities and soil carbon stocks . When management practices that deplete soil carbon stocks are reversed, grassland ecosystem carbon stocks can be rebuilt, sequestering atmospheric CO_2 (Follett *et al*., 2001).

Disturbance, such as fire, drought, disease or excessive forage consumption by grazing, can lead to substantial losses of carbon from both soils and vegetation. Emissions from conversion from forests to cropland or other land use have dominated carbon losses from terrestrial ecosystems, but substantial amounts of carbon have been lost from biomass and soils of grassland systems as well. Grassland management to enhance production (through sowing improved species, irrigation or fertilization) minimizing the negative impacts of grazing or rehabilitating degraded lands can each lead to carbon sequestration (Conant *et al*., 2001). Improved grazing management (management that increases production) leads to an increase of soil carbon stocks by an average of 0.35 Mg C ha^{-1} yr^{-1} (Conant *et al*., 2001).

Reduced carbon emissions through reduced grassland degradation: Grasslands contain a substantial amount of the world's soil organic carbon. Integrating data on grassland areas (FAOSTAT, 2009) and grassland soil carbon stocks results in a global estimate of about 343 billion tonnes of C – nearly 50 percent more than is stored in forests worldwide. Just as in the case of forest biomass carbon stocks, grassland soil carbon stocks are susceptible to loss upon conversion to other land uses or following activities that lead to grassland degradation (*e.g.* over grazing). Current rates of carbon loss from grassland systems are not well quantified. Over the last decade, the grassland area has been diminishing while arable land area has been growing, suggesting continued conversion of grassland to croplands (FAOSTAT, 2009). When grasslands are converted to agricultural land, soil carbon stocks tend to decline by an average of about 60 percent (Guo and Gifford, 2002).

Conclusion

Building soil carbon stocks through the implementation of improved/more sustainable management practices is just one component of developing more productive and efficient livestock production systems. Increasing livestock production could lead to greater CH_4 emissions, but improving feed quality by enhancing pasture management to produce forage with more balanced quality could concurrently sequester carbon, and increase milk or meat production.

Successful pilot projects carried out in collaboration with national scientists, grassland managers and development actors will play a key role in demonstrating the feasibility of new practices. At the same time, pilot projects are necessary to extend and divulgate information on the efficacy of grassland management practices as a mitigation strategy. Understanding the institutional requirements and testing carbon accounting procedures are crucial next steps for legitimizing mitigation through grassland management.

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