Managing Carbon Sources and Sinks in Australia's Rangelands and Tropical Savannas

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Background Australia's rangelands and savannas occupy about 80% of the continent and play an important role in the country's carbon balance . Grazing by livestock is the most extensive land use , and the savannas are subject to frequent , extensive fire , especially in the north , where annual rainfall exceeds 1000 mm . Savanna burning plus direct emissions from Australia's domestic livestock (mainly sheep and cattle) account for about 15 % of Australia's accountable CO_2 equivalent (CO_2-e) emissions per year . In this paper , we discuss the potential to reduce emissions via land management instruments , ecosystem capacity to sequester carbon , and investment and management strategies that can lower the carbon footprint of land use in these ecosystems .

Greenhouse gas (GHG) emissions from Australian rangelands derive from three main sources : land-use change , livestock production and savanna burning (Table 1) . Most land-use change in rangelands since 1990 has been deforestation of eucalyptus-dominated woodlands to increase pastoral production . In 1990 , the CO_2-e emissions from deforestation were double those from livestock and ca . 20 times those from savanna burning . Since then , the rate of land clearing has decreased so that the emissions in 2005 were about two thirds those from livestock .

Table 1 *Accountable greenhouse gas emissions from Australian rangelands (source : NGGIC* 2005 *)* .

Sector	Net emissions (Mt CO_2-e y^{-1})		
	1990	Range 1991-1994	2005
Land use change (deforestation)	128 .9	106 .1 to 46 .4	53 .3
Land use change (afforestation)	0	-0 .5 to -17 .8	-19 .6
Livestock (enteric fermentation and manure)	65 .9	61 .6 to 66 .1	62 .1
Savanna burning	6 .6	6 .1 to 15 .8	8 .6

GHG management There are few practical strategies to reduce methane emissions from livestock without reducing productivity . Genetic variation in the feed , and manipulation of feed quality provide potential methods to manage methane emissions from cattle . Improvement of rangeland condition may enhance sequestration , by increasing soil carbon stocks . With respect to fire , which is pervasive across the savannas , the potential to reduce GHG emissions and enhance carbon sequestration capacity is high . Current fire abatement activities over a 30 ,000 km^2 area in Western Arnhem Land , Northern Territory , are achieving accountable emissions reductions of ca . 100 000 t CO_2-e per annum . Recent research (Russell-Smith J et al . 2002 ; Williams *et al* . 2004 ; Beringer *et al* . 2007) in the mesic savannas has quantified critical components of carbon stocks and fluxes , e .g . area burnt , burning efficiencies , fuel dynamics , and net ecosystem and biome productivity (NEP ; NBP) . This indicates that the mesic savannas are net C-sink , of ca . 1-to-2 t C ha^{-1} y^{-1} . Sink strength is sensitive to fire regime , and reduction in the severity of the fire regime will lead to additional increases in carbon sequestration capacity .

Market potential International demand for ecosystem abatement and bio-sequestration activities is likely to increase in coming years . Australian rangelands and savannas , which collectively cover several million km^2 , offer significant potential to provide abatement and off-set products and services within international carbon markets , whether voluntary or regulated . We discuss this potential , and how the emerging demand for land-based carbon off-set products may affect land-management policy and practice in rangelands and savannas , within the pastoral sector , and with respect to Aboriginal people , who own extensive areas of the savannas .

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