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Title:

Adapting the Australian grassland & livestock industry to climate change by systemic adaptation: value of adaptation at cross-regional scale

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The annual net primary production of temperate grasslands and livestock industries is predicted to decrease in southern Australia with future climate change. By using biophysical modelling, we addressed productivity and profitability relative to geography, enterprise, and time, while considering various grassland management and animal genetic improvement adaptations individually or as combinations. Grazing systems were modelled at a daily time step for a historical reference period and under future climates projected for the SRES A2 scenario. We predicted that single incremental adaptations will not completely avert declines in productivity and profitability; hence, combinations of adaptations are needed. Upscaling over all southern Australia, GCMs and enterprises, the most profitable systemic combination could increase profit by +188%, +196% and +241% in 2030, 2050, and 2070, compared to no adaptation. Changes in meat production were estimated to be +24%, +25%, and +14% in 2030, 2050, and 2070 compared to average production of recent decades. The potential value of adaptation across southern Australia was estimated as 2.7, 2.5, and 2.9 billion AU$ in 2030, 2050, and 2070, respectively. Financially-motivated changes to grazing systems may affect the environmental outcomes which their tradeoffs with adaptation could inhibit the implementation of adaptations. We estimated that a full adaption of optimal systemic adaptation will result in improvement in soil environment and water use efficiency. However, it will lead to greater ruminant CH_4 emissions from 70 kg ha^{-1} yr^{-1} in baseline to 84, 83, and 75 kg ha^{-1} yr^{-1} in 2030, 2050, and 2070. Greater intensification and ruminant CH_4 emissions are likely to occur, as increasing future demand of meat has been projected and we predicted that there is capacity for higher and profitable production to respond to this demand. Future food market projections have shown great demand to meat even under higher price effects.