Bio-economic modelled outcomes of drought-related management strategies in the Mitchell grass region

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Abstract: Cattle and sheep grazing is the dominant land use in Queensland, occupying nearly 86% of Queensland's 173 million hectares. High rainfall variability (inter-annual and decadal) experienced in Queensland, coupled with drought, poses major challenges for the sustainable and profitable management of grazing businesses. Stocking rate flexibility, or the degree cattle stocking rates increase or decrease after good and poor pasture growing seasons, is reported as a key strategy for pasture management in northern Australia. The GRASP pasture and animal growth model and Breedcow & Dynama software were used to model breeding herd dynamics for four stocking rate flexibility strategies for a representative property in the Mitchell grasslands of central west Queensland. Farm management economic models were developed to examine the property-level implications of these drought-related stocking rate strategies, and herd level approaches to restocking and destocking.

A 'Set stocking' (SS) strategy, defined as the "safe" number of cattle carried on a 16,200 ha beef grazing property of specified land types, tree cover and historic climate records for Longreach, was determined in the GRASP model so that the average pasture condition (percent perennial grasses, %P) over the 36-year simulation period (1982-2017) approximated an initial 70%P. The modelled beef enterprise was a self-replacing breeding and growing operation that relied on the production of weaners. Simulated annual stocking rates and steer liveweights from GRASP, and published functions for mortality and conception rates in beef breeding cattle in northern Australia, were used to define herd composition.

Three alternative stocking rate flexibility scenarios were simulated over the same 36-year period. These scenarios differed in the degree to which stocking rates could be adjusted each year in response to changes in the amount of forage (Total Standing Dry Matter - TSDM) available for consumption at the end of the growing season (1st May). They ranged from low flexibility in 'Retain core herd' (RCH), moderate flexibility in 'Drought responsive' (DR) to 'Fully flexible' (FF). Data from GRASP and Breedcow and Dynama were used to develop property-level internal rate of return (IRR) for a 30-year period from 1988-2017.

Over the 36 years, the SS strategy achieved an average pasture yield of 1956 kg ha^{-1} and liveweight gain (LWG) of 120 kg hd^{-1} whilst maintaining pasture condition (70%P). The DR strategy achieved the best average pasture yield, LWG and percent perennial grasses (1884 kg ha^{-1}, 127 kg hd^{-1}, 70%P respectively) compared to RCH (1579 kg ha^{-1}, 108 kg hd^{-1}, 59%P respectively) and the FF strategy (1286 kg ha^{-1}, 98kg hd^{-1}, 48%P respectively). IRR of the stocking rate strategies depended on the degree to which herds were reduced and re-built in relation to drought. Property-level IRR were poor under all strategies where natural increase was relied upon to slowly rebuild cattle numbers after drought (SS, IRR= -0.09%; RCH, IRR= -0.27%; DR, IRR= -1.57%; FF, IRR= -4.44%). Positive investment returns were achieved when the DR herd was rebuilt more quickly through either cattle purchases (IRR=1.70%), steer trading (IRR= 0.50%), or agistment (IRR=0.19%). A positive IRR of 0.70% was also achieved with the FF strategy when purchasing pregnancy-tested in-calf cows to rebuild numbers.

Managing stocking rates annually with a moderate degree of flexibility in a highly variable and unpredictable environment maintained pasture condition and demonstrated the best relative property-level investment returns. The positive IRR associated with purchasing cattle, whilst negative when relying on natural increase, suggests that economic viability is favoured by re-stocking within short time-frames once good seasonal conditions return. The speed at which this could occur without impacting on pasture condition could not be adequately explored through annual stocking rate adjustments. Improvements to the modelling approach to allow dynamic and more frequent stocking rate changes would allow the testing of more complex scenarios and lead to greater insight.

Keywords: *Representative property, stocking rate flexibility strategies, herd management, IRR*