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THE UTILITY OF FORECASTING SUMMER RAINFALL AND MODELLED PASTURE GROWTH IN THE MITCHELL GRASSLANDS OF WESTERN QUEENSLAND

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INTRODUCTION

Climate has a large impact on vegetation and animal production in northern Australia. The length of the dry season, variable annual rainfall, extreme temperatures and high evaporation rates make managing pastoral enterprises difficult. Seasonal climate forecasts based on the El Niño Southern Oscillation (ENSO) can potentially be useful to graziers, particularly if forecasts can be issued with long lead-times and blended with animal and pasture management practices. Previous studies have shown large changes in rainfall (27%) and larger changes in pasture growth (35%) associated with changes in the Southern Oscillation Index (SOI) (Park *et al.* 2001). These results indicate a potential benefit in forecasting pasture growth compared to rainfall. This paper evaluates the potential use of long lead seasonal forecasts using summer rainfall and pasture growth.

MATERIALS AND METHODS

Relationships of SOI and SST based seasonal forecast systems with summer rainfall (November to March) and modelled pasture growth were assessed with monthly lead-times of 0 to 6 months for Longreach and 40 other locations across the Mitchell grasslands of western Queensland using AUSTRALIAN RAINMAN (Clewett et al. 1999). The period of analysis was November 1891 to March 2002 (111 seasons). Three seasonal forecast systems were used: Average 3 month SOI (Clewett *et al.* 1991), SOI Phases (Stone and Auliciems 1992) and SST 9 Phase (Drosdowsky 2002). A concurrent analysis using Average SOI (November to March) was also assessed. Daily climate data was sourced from the SILO data drill (Jeffrey *et a*l. 2001) and estimates of summer pasture growth were modelled using WinGRASP (McKeon *et al.* 1990). Modelled growth of Mitchell grass pastures explains about 70% of the variability of actual pasture growth (Cobon, unpublished data). The same pasture parameters were used for all sites, thus the only source of variation in pasture growth was the climatic data. Strength of seasonal forecast relationships was measured by percent change in rainfall and pasture growth (Park et al. 2001). The Kruskal-Wallis (KW) (Conover 1971) and cross-validated Linear Error Probability Space (LEPS) continuous skill score (Potts et al. 1995) tests assessed the statistical significance of SOI and SST relationships with rainfall and pasture growth. Statistical significance was indicated if KW and LEPS were at least 0.9 and 7.0 respectively (LEPS significance threshold - Clewett, unpublished data). Correlations of Average SOI with rainfall and pasture growth were also calculated.

RESULTS

Mean summer rainfall for the 41 stations was 314 mm and highly variable (Coefficient of Variation, 53%). Mean summer pasture growth was 1370 kg/ha and varied more than rainfall (C of V, 81%). In years with a negative average SOI during summer (22 seasons below –5) mean rainfall was 14% lower, compared to all years. Conversely, when the SOI was positive (32 seasons above +5) the mean rainfall was 27% higher. The average impact of ENSO was a change in mean rainfall of 21%. Impacts of ENSO on pasture growth were greater (31% on average) with a mean reduction of 28% when the SOI was negative, and an increase of 34% when the SOI was positive. ENSO influenced rainfall and pasture growth in the concurrent analysis when the Average SOI was used, however the influence declined as lead-time increased (Figure 1). For example, the impact of ENSO was >10% at lead-times of 0 to 3 months for rainfall and 0 to 5 months for pasture growth.

However, the apparent impacts of ENSO were only statistically significant for lead-times of 0 and 1 month at most locations (Figures 2 and 3). The results from the SST 9 Phase analysis showed few stations with statistical significance (KW > 0.9) at 0, 1 and 2 months lead time (15, 2 and 12 stations respectively), and therefore these results are excluded from Figures 2 and 3. Significant correlations existed between Average SOI and rainfall (0 and 1 month lead-time) or pasture growth (0 to 3 month lead-time) at more than 37 locations (Figure 4).

DISCUSSION

Impacts of ENSO on rainfall (>10% from 0-3 months lead-time) and pasture growth (>10% from 0-5 months lead-time) were not statistically significant for most locations beyond a 1 month lead-time using Average SOI or SOI Phases. SST Phase relationships were not significant beyond a 0 month lead-time, which agrees with the 1 month lead-time/3 month seasonal analysis (Drosdowsky 2002) for the summer season in this part of Australia. While ENSO had a bigger apparent impact on pasture growth than rainfall for longer lead-times (5 versus 3 months), significance tests showed little advantage in using modelled pasture growth over rainfall. However, correlations indicated an apparent advantage in using the Average SOI to forecast pasture growth compared to rainfall (3 versus 1 month lead-time). The interpretation of different statistical tests needs more work. The high inter-annual variation in rainfall extrapolates to extreme inter-annual variation in pasture growth. Large differences in rainfall between El Niño and La Nina summers were evident with greater differences in pasture growth. However, highly variable data are antagonistic to statistical significance and so large impacts that stretch to lead-times of 3-5 months are not transferred to statistical significance beyond 1 month.

The spatial variability shows that when providing a forecast at a particular location it is important to look at other sites around that location to ensure a similar forecast signal is evident. There are no major geological features in the Mitchell grasslands that would explain major differences in climate between neighboring locations. Therefore, if surrounding sites are similar there is a greater chance of the outcome being real. Forecast lead-times of 5 months are important for graziers to better manage climate variability. While the forecast systems tested in this study did not give an extended lead-time beyond 1 month, other forecast systems involving climate signals with longer lead-times are currently being developed.

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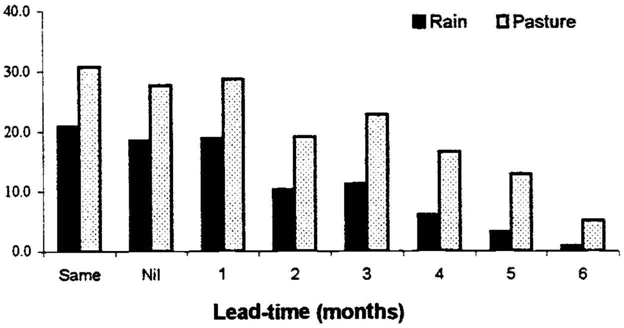


Figure 1. Percent change in mean rainfall and pasture growth using a concurrent analysis and various lead-times.

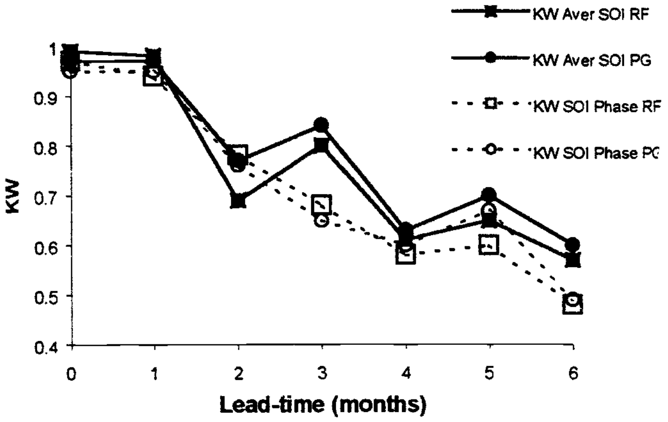
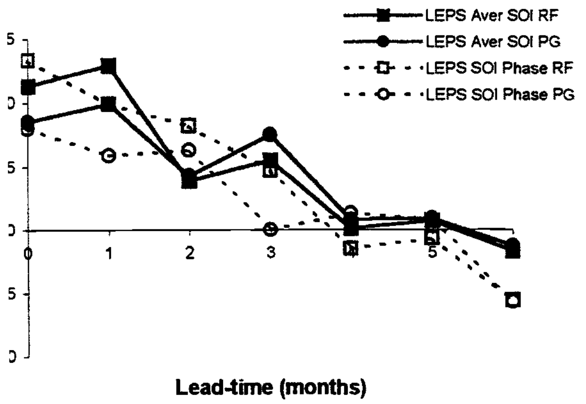


Figure 2a. Median KW values of 41 locations using the "Average SOI" and "SOI Phases" forecast systems.



gure 2b. Median LEPS scores of 41 locations ng the "Average SOI" and "SOI Phases" ecast system.

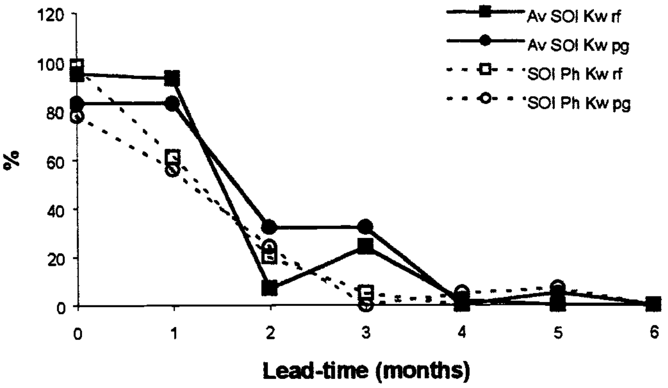


Figure 3a. Percent of locations with a KW value of at least 0.9 using the "Average SOI" and "SOI Phases" forecast systems.

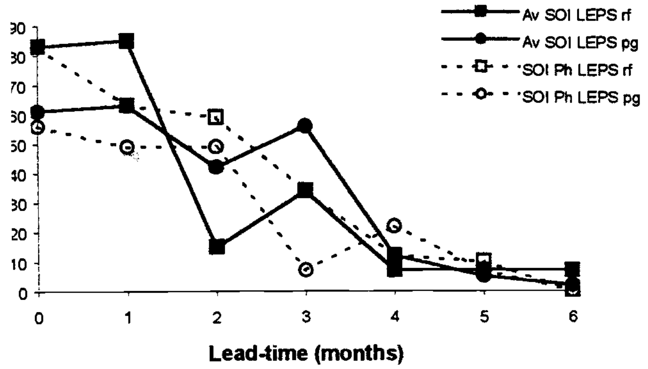


Figure 3b. Percent of locations with a LEPS score of at least 7 using the "Average SOI" and "SOI Phases" forecast systems.

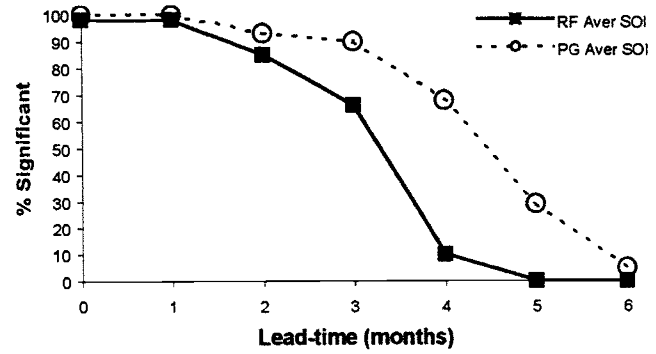


Figure 4. Percent of locations with a significant correlation (>0.156) using the "Average SOI" and "SOI Phases".