111

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Northern Australia's Green Break of Season (GBOS) dates and their relationship with pasture

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Abstract

Across northern Australia's rangelands, livestock production depends heavily on rain-fed pastures that rely primarily on rainfall during the wet season months of October to April. Planning for the onset of pasture growth (called green cover onset) after the dry season enables graziers to set appropriate stocking rates based on the available fodder at the end of the previous growing season. This reduces costs and alleviates the strain on existing livestock. This study focuses on the 'green break of season' (GBOS) date, defined as the first occurrence of meaningful rainfall over a 3-day period after the dry season, and its relationship to the green cover onset. By utilising robust model-derived estimates and satellite observations of pasture growth at representative locations, we examine the relationship between the green cover onset and GBOS for various rainfall thresholds and find a strong linear relationship. Additionally, we investigate the historical or long-term 'green date', at which the GBOS reliably occurs in 70% of all years. We analyse the spatial distribution of green dates over northern Australia and examine how these dates are influenced by the phase of the El Niño-Southern Oscillation. Ultimately, our findings aim to assist producers and graziers in determining their "decision date" for better management of livestock and resources.

Introduction

Australia is the world's third-largest exporter of beef (Meat & Livestock Australia, 2022) and relies heavily on pasture to feed cattle in its northern regions. Pasture growth and cattle liveweight gains in northern Australia are closely linked to October-April wet season rain, which accounts for over 90% of the area's annual rainfall (Lisonbee et al., 2022). Northern Australia also experiences substantial seasonal and interannual rainfall variability, sometimes resulting in droughts and floods (Thi Tran et al, 2016; Johnson et al. 2016). These conditions affect cattle enterprise management and livestock production (Cobon et al., 2019), creating challenges in balancing forage supply with herd sizes (Cobon et al., 2020b) and significant financial risks.

There are various rainfall-based definitions to help estimate the timing of new pasture growth for grazing management, such as the "green season" (McCown, 1981), "green break of season" (Balston and English, 2009), and Northern Rainfall Onset (NRO) (Cowan et al., 2020; Drosdowsky and Wheeler, 2014). These definitions highlight the complexity of identifying a singular onset date for productive green pastures. In this study, we define the Green Break of Season (GBOS) as the first day after 1 September when 50 mm of rainfall accumulates over three consecutive days. The GBOS signals the anticipated start of pasture growth, initiating green cover and supporting liveweight gain in stock (Balston and English, 2009). We then examine the Green Date (GD), commonly used in the grazing industry (FutureBeef, 2021), defined as the date representing 70% of GBOS dates across all historical years. By combining the GD with an estimated end of growing season date, producers can set an appropriate dry season stocking rate, crucial for maintaining land and pasture condition (O'Reagain et al. 2009). Understanding the GD helps graziers ensure sufficient feed for livestock and maintain adequate groundcover in most years (FutureBeef, 2021, Meat & Livestock Australia, 2018). The aim of this paper is to 1) evaluate the capability of short-term rainfall accumulations to predict the onset of pasture growth at a representative location in northern Australia and compare this approach with the NRO; and 2) investigate the distribution of GDs across northern Australia with respect to ENSO phases.

Methods

Our study investigates the effectiveness of a 3-day rainfall accumulation as a measure for defining the GBOS across northern Australia (10°S-29°S, 112°E-154°E). Using historical rainfall observations, we evaluate the capability of short-term rainfall accumulations to represent the onset of pasture growth and compare this approach with the Northern Rainfall Onset (NRO).

We use gridded daily rainfall observations (1900–2023) from the Scientific Information for Land Owners (SILO) database (Jeffrey et al., 2001) to calculate GBOS, NRO and GD, and the grass production biophysical model GRASP (Rickert et al., 2000) to estimate daily pasture growth (1990–2020), based on long-term grazing trials at Wambiana Station (20° 34' S, 146° 07' E) in northern Australia (O'Reagain et al. 2009).

We define the GBOS as the first occurrence of a 3-day rolling sum of 50 mm rainfall between September 1 and April 30 (with additional thresholds ranging from 10-80 mm also tested). The GD is defined as the date on which 70% of all historical GBOS events occur. During El Niño and La Niña years, we identify the reliable GBOS using a 70th percentile threshold for GBOS in those years, based on average Southern Oscillation Index (SOI) values exceeding ±5 from June to November (Allan et al., 1996). A Student's t-test is applied to assess significant differences between the reliable GBOS during ENSO years and the GD for all years.

We use the green cover variability dataset (1990–2020) from Wambiana, to calculate the Green Cover Onset (GCO), which is defined as the date when green pasture cover reaches and sustains a minimum of 5% after 1 October. The relationship between GBOS and GCO is evaluated using statistical regression analysis, with confidence intervals calculated at the 95% level.

Results

The Green Date (GD)

Figure 1 illustrates the GD at Longreach (23.45°S, 144.25°E; central Queensland) which occurs significantly earlier during La Niña years and later during El Niño years compared to all years. This timing is consistent with the ENSO-driven rainfall patterns in northern Australia (Cowan et al., 2020). The overall 50 mm threshold GD spatial pattern for northern Australia, demonstrates early onsets in the north and northeast regions, with later GDs in central and interior regions (not shown here but refer to Fig. 3 in Naha et al., unpublished manuscript/pers. comm.).

Green Cover Onset (GCO) at Wambiana and its relationship with GBOS and NRO

The analysis of GCO at Wambiana highlights instances of false starts and false dry periods, demonstrating cases where early pasture growth fails initially due to insufficient follow-up rainfall (Figure 2a), or exceeds a certain threshold value (e.g., 2.5%) and maintains a marginal green cover during the cooler months (e.g., July-August; Figure 2b). Thus, careful identification of sustained green cover is essential.

The regression analysis between the GCO and GBOS shows a strong correlation between the two variables, particularly at a 50 mm threshold (Figure 3), explaining about 94% of GCO variability with respect to any change in GBOS. This suggests 50 mm as an optimal threshold for predicting GCO at Wambiana. Furthermore, the analysis comparing the NRO and GBOS (Figure 3) reveals a stronger correlation between GBOS and GCO ($R^2 = 0.94$) than that between NRO and GCO ($R^2 = 0.62$), suggesting that GBOS, which reflects short bursts of rainfall, is more effective than NRO for determining the onset of pasture growth at Wambiana.

Discussion

Our study investigates the timing and reliability of the GBOS, a rainfall-based metric aimed at marking the onset of new pasture growth in Australia's northern tropics. By examining the correlation between GCO and GBOS, calculated using various rainfall thresholds (not shown), at a representative location in northern Australia (Wambiana), our research highlights that 50 mm over three days offers the most ideal threshold in determining the relationship between GCO and GBOS at this location, with an explained variance being greater than 94%. At this threshold, the GCO demonstrates a stronger correlation with GBOS than with the NRO, providing the first clear evidence that pasture growth is more related to short bursts of rainfall, than the slower accumulation of rainfall (as observed for Wambiana). This suggests that GBOS may be a more effective indicator for determining the onset of productive pasture. The study also examines the historical GD, representing the start of the pasture growing season and the climatological GBOS across northern Australia. This analysis reveals significant shifts during La Niña years, which tend to advance the onset of pasture growth through earlier effective rainfall. The findings have practical implications for graziers, enabling them to better estimate pasture availability and prepare for stocking and feeding through the dry season. By understanding regional GD patterns and the influence of ENSO phases, graziers can plan ahead for livestock needs, optimising decisions on calving/lambing and stocking rates.

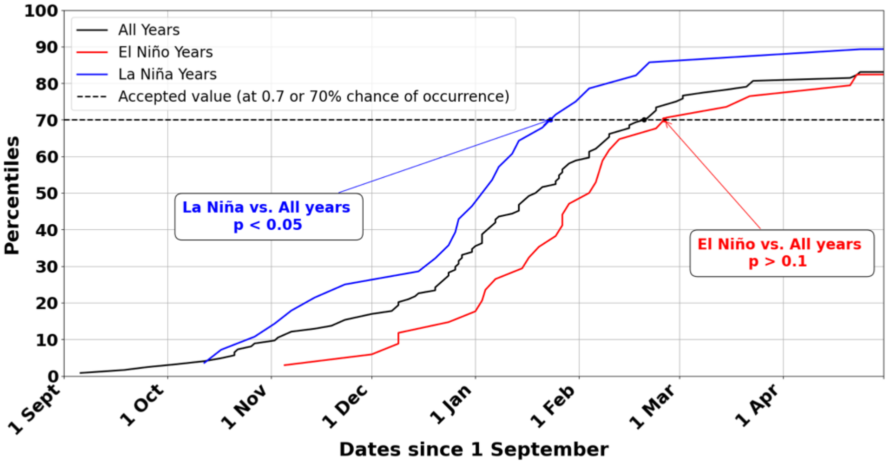

Figure 1: Percentiles of GBOS for Longreach (23.45°S, 144.25°E) from 1900 to 2023, determined using a 50 mm threshold over 3 days. The black dashed horizontal line indicates the 70th percentile, which defines the GD. The solid black, red, and blue curves represent the GBOS percentiles for all years, El Niño years, and La Niña years, respectively. P-values shown are from a Student's t-test comparing the reliable GBOS during ENSO years with the GD for all years.

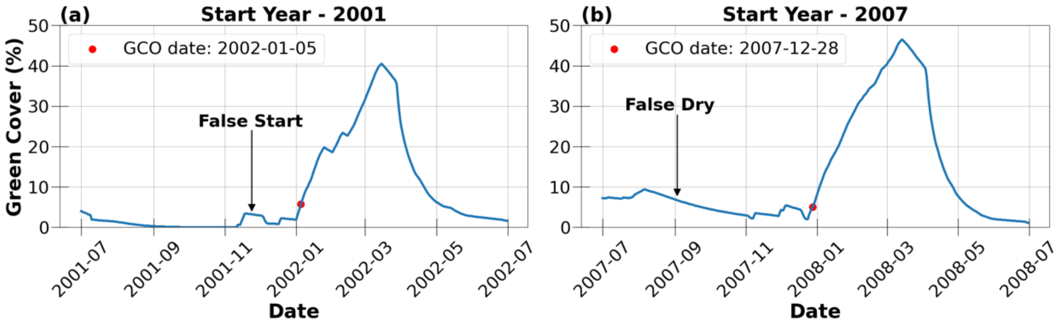

Figure 2: Examples of (a) a 'False start' in green cover onset (2001), and (b) a 'False dry' in green cover (2007).

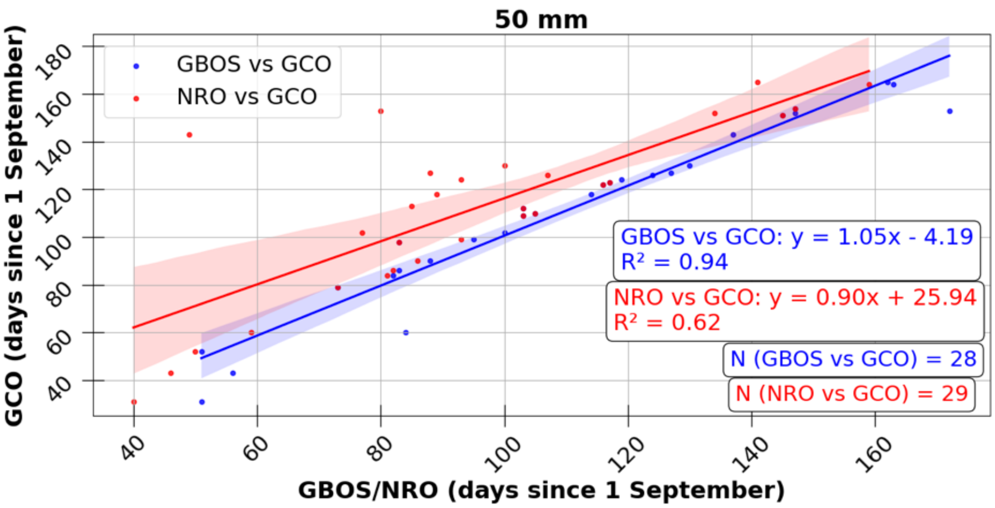

Fig. 3: Linear relationship between GBOS versus GCO and NRO versus GCO at Wambiana Station for a rainfall threshold of 50 mm from 1990 to 2020. The blue shading in the background represents the 95% confidence intervals. The letter 'N' denotes the number of data points included in each regression analysis.

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