

Behavior, Welfare, and Performance of Beef Cattle Grazing Grass Monocultures Improved by Islands of Forage Diversity

Abstract: This study evaluated how smart foodscapes (SFT) modify grazing behavior and cow–calf performance. Thirty Angus cow–calf pairs were assigned to six 9-acre meadow brome paddocks (5 pairs·paddock⁻¹): three grass monocultures (CT) and three SFT paddocks containing three fenced “islands of diversity” seeded with alfalfa, sainfoin, small burnet, and forage kochia. Grazing occurred from July to September in four 15-d periods; Period 4 served as a grass-only baseline. During Periods 1–3, SFT cows accessed one island daily for 1 h in the evening. Diet selection was quantified using video-based 2-min scan sampling and pre- and post-grazing biomass. Cows were fitted with GPS collars integrating tri-axial accelerometers and pedometers. Treatment effects were analyzed with mixed-effects models including period as a repeated measure, and machine learning (5-fold cross-validation) was used for behavioral classification. An XGBoost model achieved 84.4% accuracy for behavioral states and 72.9% for foraging events. Grass disappearance did not differ between treatments ($p = 0.18$). SFT cows shifted from weed-dominated diets (30–35% to 15–20% of scans) toward sainfoin- (25–30%) and alfalfa-rich (15–20%) diets ($p < 0.001$). Forage mixing increased within 10 min of island grazing, indicated by reduced Bray–Curtis dissimilarity (>0.55 to < 0.35) and greater evenness ($MS \rightarrow 0$). SFT cows showed greater daily activity (motion index: 11,539 vs. 7,738 units·d⁻¹; $p = 0.0002$) and fewer lying-to-standing transitions (13.6 vs. 34.8%; $p < 0.0001$). SFT cows traveled greater distances during evening grazing in Periods 2 and 3 ($p \leq 0.0298$), and this effect persisted in Period 4 ($p = 0.0292$), averaging 1.25 m more per evening bout than CT cows across Periods 2–4 (13.19 ± 0.15 vs. 11.94 ± 0.16 m), with no differences during night, morning, or afternoon ($p \geq 0.0854$). Relative energy expenditure (accelerometer-derived cumulative activity index) did not differ between SFT and CT cows during Periods 1–3 (0.452 ± 0.003 vs. 0.441 ± 0.003) or Period 4 (0.453 ± 0.006 vs. 0.444 ± 0.006 ; all $p \geq 0.1369$). SFT cows had greater ADG (0.53 vs. -1.31 kg·d⁻¹; $p < 0.0001$; Periods 1-3) and (-0.17 vs. -1.03 kg·d⁻¹; $p = 0.0001$; Period 4). SFT calves also had greater ADG (0.67 vs. 0.48 kg·d⁻¹; $p = 0.031$; Periods 1-3) and (0.12 vs. 0.08 kg·d⁻¹; $p = 0.032$; Period 4). SFT cattle were more active in the afternoon and evening, whereas CT cattle were more active in the morning. Overall, small and targeted forage patches shifted grazing behavior, enhanced activity and movement, and improved cow–calf performance and welfare without increasing movement energy cost.