



Session 1: Veld productivity and quality

Chair: Igshaan Samuels

Progress made on using earth-observation-based estimation of grass nutrients and biomass as indicators of rangeland (forage) quality and quantity in the savanna environments

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Traditional means of assessing leaf nutrients and biomass as indicator of grass or rangeland quality and quantity for wider area is stymied by expensive labour costs and tedious methods. Leaf nutrients such as leaf nitrogen (N) and biomass varies over variety of scales. Estimation of these variables for larger areas can only be achieved using earth observation, such as remote sensing sensors to provide synoptic views of the landscape. Spatially-explicit information on grass quality and quantity is crucial to inform decision making for planning and management of savanna ecosystems. These variables are critical for spatial zoning of grazing camps, deriving carrying capacity of herbivores and disease contact risk models. Leaf N and biomass play a crucial role in understanding the distribution, densities and feeding patterns of both wild herbivores and livestock. Leaf N is one of the major nutrient requirements for herbivores, and known to positively correlate with protein, while biomass is a measure of available grazing resource for animals. Leaf N estimation has been foiled by the paucity of satellite-based sensors that sample reflected electromagnetic energy in the red-edge region sensitive to foliar chlorophyll and N. Medium resolution satellites such as Landsat, SPOT and MODIS are also generally not suitable to discriminate grass and tree signals in heterogeneous and patchy savannas. The emergence of high-resolution multispectral sensors with red-edge information such as RapidEye, SumbandilaSat, and Sentinel-2 (to be launched 2015) provides new opportunities for rangeland quality assessment at regional level. Biomass estimation accuracy using remote sensing has been challenged by the signal saturation problem; this is rather minimized with the use of the red-edge band. The objective of the study is to review the studies focusing on the earth-observation-based estimation of leaf N and biomass as indicators of rangeland quality and quantity at various scales. The case study for this review covers studies undertaken around the Kruger National Park (KNP), Sabi Sands and Bushbuckridge communal rangelands for the past 5 to 10 years. The studies that assessed the utility of the red-edge band from the new generation of remote sensing data were prioritized. Most of the studies concurred with the fact that the use of red-edge band improves estimation of leaf N and biomass as compared to conventional remote sensing sensors. The first regional map for leaf N was generated with the use of the commercial satellite sensor such as RapidEye, and then the World View-2. The launch of Sentinel-2 with the red-edge band will thus provide opportunities to accurately map leaf N and biomass with freely available data. The study demonstrates the progress in estimating leaf N and biomass from local to regional scale to inform the decision makers (farmers, resource and park managers as well as policy makers) for effective planning and management of the savanna ecosystems.

Keywords: leaf nitrogen, biomass, remote sensing, estimation, mapping, earth observation, rangeland, livestock, wildlife, savanna



Herbaceous plant species richness: How does it relate to grazing veld condition?

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A vegetation study was conducted in twelve plots within the Moist Midlands Mistbelt grassland in KwaZulu-Natal, with the aim of investigating whether a relationship existed between the grazing veld condition and herbaceous plant species richness. The objectives included determining veld condition for the twelve respective plots using the benchmark method, determining the herbaceous plant species richness using the Jackknife Estimate of Species Richness and ultimately conducting a correlation analysis between veld condition scores and species richness. The results revealed that there was no relationship between grazing veld condition and species richness ($r = -0.2723$, $P = 0.392$, $df = 10$, $n = 12$). Veld condition scores ranged from 2.43 – 120.65% whereas species richness ranged from 46 – 107 (observed) and 60 – 136 (estimated) species per plot. There was a positive curvilinear relationship between observed grass and forb species richness ($r = 0.5478$, $P = 0.0652$, $df = 10$, $n = 12$). It seemed that sites which were found to be in poor condition from a grazing perspective could still be valuable for biodiversity conservation by virtue of their high species richness. Caution should be exercised to avoid treating weedy annual species as equal to the robust perennial species when using species richness as an indicator of biodiversity value. This means that veld condition scores cannot be used as indicators of species diversity and vice versa. This finding has implications for decision-making processes pertaining to land-use development applications which are evaluated by nature conservation authorities as it indicates that grazing veld condition score is not sufficient to conclude whether or not a particular site is of low or high biodiversity value. Therefore, the assessment of veld condition for biodiversity purposes still requires different approaches to those used for grazing veld condition and these could include diversity indices and others.

Keywords: grazing, plant-herbivore interactions, rangeland condition, veld assessment



Effects of tannins on body weight, faecal nitrogen and nutritionally related blood metabolites of free-ranging goats in African savannas

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Current understanding of the effects of condensed tannins (CTs) on large herbivore productivity is largely based on results from simple lab and feeding experiments with captive animals. There is, therefore, an urgent need for field experiments that capture the complex behavioural and physiological responses of herbivores to plant secondary chemistry to better understand how individual differences and environmental conditions influence growth and productivity of large herbivores. In a field experiment, we tested whether CTs reduce body weight of goats by reducing nutrient absorption and increasing faecal nitrogen excretion. Forty-five female goats were divided into three groups and orally dosed each day with either CTs, polyethylene glycol 6000 (PEG, a polymer that neutralizes dietary tannins), or water. We measured average daily body gain, body weight, faecal nitrogen and four blood metabolites from all goats in the dry and wet seasons. The average daily body gain for animals dosed with PEG was higher than that of CT and control goats. Repeated measures of body weights were not influenced by the treatment but significantly increased over time within seasons. CT dosed goats excreted the highest faecal nitrogen and had the lowest blood protein concentrations, while the opposite was true for PEG goats in both seasons. Other blood metabolites indicated a negative influence of CT on energy and protein metabolism. Despite the observed potential to reduce nutrient absorption and increase nitrogen excretion, CTs did not affect growth performance. However, PEG's ability to increase the average daily body gain, reduce nitrogen excretion and increase circulatory nutrients indicates that diet composition of free ranging goats can have large influences on goat productivity.

Keywords: productivity, growth rate, performance, nutrient, absorption, goat production, ruminant nutrition



Influence of tannin-rich *Acacia karroo* on blood profile of indigenous Pedi goats

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Acacia karroo is a promising fodder for goats during the critical dry season in communal rangelands. The only limitation to the use of this browse legume is the presence of condensed tannins. A study was conducted to investigate the effects of tanniniferous *Acacia karroo* (A) on blood profiles of indigenous Pedi goats fed *Setaria verticillata* (S) hay as a basal diet. Twenty apparently healthy indigenous Pedi goats weighing 18 ± 2 kg were randomly divided into five groups of four animals per group. Each group was assigned in a completely randomized design to the five treatments which include S80A20, S75A25, S70A30, S60A40 and S50A50 and fed for 22 days. 10 ml of blood samples were collected from the jugular vein on the last day for haematological and serum biochemical assays. White blood cell, red blood cell, haemoglobin, haematocrit, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration were not influenced ($p > .05$) by the dietary treatment. Serum biochemical parameters were also similar ($p > .05$) among the treatments except for total protein (TP). Goats on diets S60A40 and S50A50 had significantly reduced serum TP (64 and 58 g.l^{-1} respectively). The reduced serum TP can be associated with the presence of anti-nutritional factor, that is, tannin present in *Acacia karroo*. Most of the haematological and biochemical values obtained were within the normal range for healthy goats. Inclusion of *Acacia karroo* in the goat's diets up to 30% had no deleterious effect on the blood profile indices. Haematological tests might be helpful in understanding the health and immune status of indigenous Pedi goats supplemented with tannin-rich *Acacia karroo*.

Keywords: blood profile, tannin, goats, total protein



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Effects of post burn re-growth and protein supplements on foraging behaviour and diet selection of goats

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Encroaching woody plant species negatively affect rangeland productivity by reducing carrying capacity for livestock. The increase and the redistribution of woody plant species remains a challenge to farmers interested in grass production for their livestock. The objectives of this study were to determine the effects of strategic supplementation using post-burn regrowth and protein licks to increase the intake of chemically defended *Acacia karroo* trees by goats. Goats were subjected to the following treatments: control (no post-burn regrowth and no protein licks), post-burn regrowth (i.e. using fire), protein licks, and post-burn regrowth + protein licks. The interaction of post-burn regrowth, protein licks and season ($p < .034$) as well as fire and season ($p < .033$) had a significant effect on bite rate during grazing (of grasses) by goats. However, there were no significant effects of fire (post-burn regrowth), protein licks, season and their interaction on bite rate by goats during browsing of *A. karroo* trees. Goats are opportunistic feeders and have the ability to select plants that are most nutritious. The significant effect of post-burn regrowth, protein licks and season support strategic use of protein supplementation to increase the use of herbage, which may be advantageous in managing the encroachment of woody plant species.

Keywords: woody plant encroachment, herbaceous layer, post-burn forage, prescribed burning, plant secondary metabolites, bush encroachment



Long term effect of fire season on photosynthetically active radiation, leaf area index, biomass production and soil chemical properties in the Döhne Sourveld of Eastern Cape, South Africa

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A study was conducted on the long-term burning trial in the Döhne Sourveld to investigate the effects of seasons of burning on species composition, fraction of photosynthetically active radiation (fPAR), leaf area index (LAI), biomass production and soil chemistry. The trial was established in 1988 at the Döhne Agricultural Development Institute and treatments comprised of July, August, September, October and November burns applied between 15 July and 15 November. Each treatment was replicated three times in a randomised block design. Botanical composition of herbaceous species was determined using the nearest plant method. Species diversity was determined using the Shannon-Wiener Index. fPAR was measured using an AccuPAR LP-80 ceptometer, and the corresponding LAI values computed. A disc pasture meter was used to determine above ground biomass. Biomass below the disk was harvested, dried and weighed. The effects of season of burning on species abundance were tested using two-way ANOVA, while treatment effects on light interception, biomass production and soil chemical properties were tested using one-way ANOVA. Soil samples were collected and analysed for C, N, P, K, Mg, pH, Zn, Mn and Fe contents. The grass species comprised three Decreaser species, four Increaser I and fourteen Increaser II. Increaser I were the most abundant (52%), while Decreaser species were the least abundant (16%). *Tristachya leucothrix* was the most abundant species across all the treatments. Burning treatments resulted in no significant effect on species diversity ($p > .05$). In June 2012, burning treatments yielded no significant effect on fPAR ($p > .1$), but in January 2013, the fPAR was significantly affected by burning treatments ($p < .1$). In winter survey, LAI in winter survey was significantly affected by the season of burn ($p < .1$) with the November burn being significantly lower than the September burn. Burning treatments had no significant effect on biomass production both in winter and summer surveys. Pairwise comparisons showed that the August burn had the highest mean biomass production than all other treatments ($\text{kg} \cdot \text{ha}^{-1}$), while the September burn resulted in the lowest ($p > .1$). Regression results showed a positive correlation between the biomass production and settling height of the disc pasture meter. Burning treatments had no significant effect on N, P, K, Mg, C, pH, Zn, Mn and Fe contents ($p > .1$) for both the winter and summer surveys. The Zn content was significantly the lowest in September and November fire treatment ($p < .1$) during summer survey. The August and November burning treatments had significantly higher Mn quantities than all other burns ($p < .1$) in winter survey. The Mn content was significantly high in August and November burning treatments. It is recommended that the Döhne Sourveld should be best burnt in October and November because the decreaser species *T. triandra* had highest relative abundance during this period.

Keywords: fire, grassland, photosynthetically active radiation, leaf area index, biomass production, season, veld condition