Operator Bias and the Effect of Training on Visual Assessments of Pasture Yield for Forage Budgets in Northern Australian Savanna

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Operator bias and the effect of training on visual assessments of pasture yield for forage budgets in northern Australian savanna

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Introduction

Sustainable management of Australia's extensive northern grazing lands is challenging given its highly variable inter-annual rainfall and pasture production. Accordingly, a key management recommendation is to adjust stocking rates to match forage supply (O'Reagain *et al*., 2014). 'Stocktake' is a forage budgeting system (Aisthorpe *et al*., 2004) widely used and promoted to assist graziers make short-term (<1 year) adjustments of stocking rate. Budgets are typically calculated at the start of the dry season, to ensure sufficient forage for stock and ground cover levels until the first rains some six to nine months later. The software application 'Future Beef Stocktake Plus' has also been developed for use on smart devices (http://www.stocktakeplus.com.au/).

A key requirement for forage budgets is an accurate estimate of pasture mass. This is typically done visually with the aid of photo standards of pasture mass, providing a simple, efficient and non-destructive approach. Other key variables of forage budgeting include the percent of the pasture not likely to be consumed by livestock (i.e. percent unpalatable) and pasture wastage that occurs as a result of trampling, decay, leaf drop and consumption by insects. Despite adoption of the Stocktake forage budget system by graziers, key variables do not appear to have been investigated and uncertainty exists on the accuracy of pasture yield estimates. Accordingly, the degree of error, operator variability and the potential impact of factors such as land type and starting yield on yield estimates and hence, calculated stocking rates, are unknown.

This study examined operator bias associated with the visual assessment of pasture total standing dry matter (TSDM) using photo standards and the extent to which this bias was affected by operator, land type and starting yield. The effect of training on operator yield assessments was also investigated.

Materials and Methods

Two trials were conducted on the Wambiana grazing trial, 70 km S of Charters Towers (O'Reagain *et al*., 2009). The vegetation is a Eucalypt savanna with average annual precipitation of 650 mm.

Trial 1: In October 2014, twenty-seven sample sites (each $25m^2$) were marked out on the three land types: Box, Ironbark and Brigalow. Sites were selected to provide a range of pasture TSDM from very low to very high across all land types. Ten operators of varying ages and experience in pasture yield estimation using photo standards were recruited.

Operators were randomly allocated to one of three independent groups that assessed the marked sites in a different sequence. Each operator was given a set of eight land-type specific photo standards to use when estimating pasture yield. Operators made independent assessments at each site of TSDM (kg/ha).

Actual yields for each site were estimated from the mean of three $1m^2$ pasture cuts, distributed so as to represent the average yield.

Trial 2: In June 2015, eighteen $25m^2$ sample sites spanning the three land types were marked out and nine operators recruited. A full range of yields for each land type similar to the previous trial was not possible due to drought. Operators made an initial visual assessment at all sites using the approach described earlier. A training session followed to allow operators to calibrate themselves against a different set of five sites of known yield. All eighteen sites were then re-assessed. Operators were also asked to rate the usefulness of photo standards at each sampling site, pre- and post-training. After the trial, actual yields for the eighteen sites were determined by harvesting and weighing the entire site.

Statistical analysis: For trial 1, the difference between the actual and estimated yield was calculated for each operator for each site as an estimate of the bias of measurements from the actual yield value. Multiple linear regression was performed using GenStat (17.1 ed. VSN International) to assess the relationship between the bias and the actual yield values, operators and land types.

For trial 2, the bias for each operator for each site was estimated as described above. This was done for both pre- and post-training assessments. The effect of training was tested using a grouped linear regression. A mixed model analysis using residual maximum likelihood (REML) was then used to test the fixed effects of operator, training and landtype and their interactions, whilst also accounting for the potential random effects, such as 'site'. The Akaike information coefficient was used to assess random models and the fixed model was refined using a backwards selection approach. Frequencies for each 'usefulness' rating of photo standards by each operator was analysed using a generalised linear mixed model.

Results and Discussion

Trial 1: The three way interaction with land type, the two way interactions with land type and the main effect of land type were all not significant ($p>0.05$), indicating land type did not influence the accuracy of pasture yield assessments. The interaction between operator and the actual yield was highly significant ($p<0.001$, adj $R^2=0.572$). This indicates the bias in estimation differed between operators. The tendency for operators to overestimate yield when actual yields were low but to underestimate yields when actual yields were high was a key finding of the study (Fig 1).

These findings indicate that operators tend to overestimate yields and hence stocking rates for paddocks with low TSDM. This has potentially serious, adverse consequences leading to overutilization of the feed base, resource degradation and poor animal production. Conversely, feed would be underutilised in paddocks where budgeting is done with higher starting yields. These results highlighted the need to provide training to improve operator's accuracy in pasture yield estimation so to ensure greater confidence in setting stocking rates.

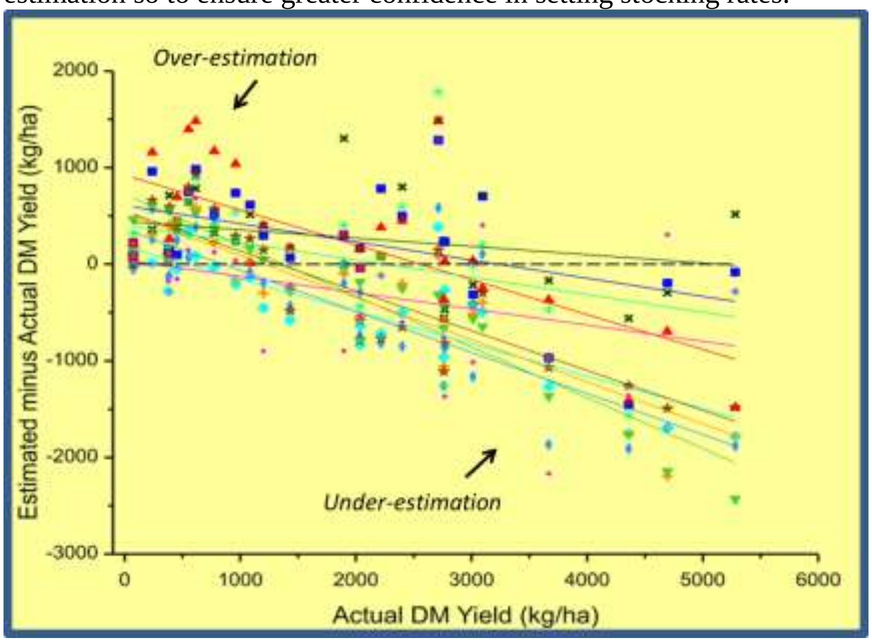

Fig. 1: Deviation of visual yield estimates from actual yields for ten operators across twenty-seven sites in a dry tropical savanna, Qld Australia. Operators are represented by different symbols.

Trial 2: The grouped linear regression indicated parallel slopes were appropriate for the pre- and post-training data. However, the adjusted R^2 value was only 0.159. The REML model indicated no significant effect ($p>0.05$) of the three-way interaction including landtype, the two-way interactions including land type or the main effect of land type. The final model, including site as a random effect, was Operator + Training + Operator. Training. The Operator. Training term was significant ($p<0.001$). The training had a significant effect ($p<0.05$) on visual estimates for seven of the nine operators. Training improved accuracy for only four of the operators; for two of these the improvement was marked and resulted in a 6- and 9-fold improvement.

The perception of how useful the photo standards were pre- and post-training was significantly different between operators ($p<0.05$). Notwithstanding these differences, there was a tendency for operators to rely less on photo standards after training, as indicated by a shift in ratings for the usefulness of photo standards pre- and post-training (data not shown). This may be a result of training, where operators may have become more critical of their own assessments after training and relied more on their memory of the training sites. Regardless, the use of a 2-dimensional image to assess a 3-dimensional pasture has its limitations. Finally, the influence of operator's level of experience on yield estimates was not clear.

Conclusions

Setting stocking rates based on visual estimates of pasture yield needs to be done with caution and due regard for the inherent errors with the procedure. There is a need to develop a standardised procedure that will improve the accuracy of pasture estimates and this may need to be customised to different operators. Training can play an important role in standardising the way operators make visual assessments of pasture yield. Further improvement to pasture photo standards and implementation of self-calibration techniques for operators may prove to be key to the precision of forage budgeting. Further work will be done to develop practical guidelines for estimating TSDM of large spatially variable paddocks and validate Stocktake estimates of stocking rates with graze-out trials.

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