Comparison of two non-destructive techniques to determine DM yield in the tropics

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Abstract

Dry matter yield determines both stocking rate and animal carrying capacity on farms, but to estimate such indicators, accurate yield measures are required. Some common techniques to estimate biomass in pastures are cumbersome, which makes producers reluctant to undertake measurement. In temperate grazing systems, use of plate meter devices has improved frequency of measurement. However, plate meter calibration equations were developed with temperate grasses (i.e. ryegrass, fescue, etc), and their use in the tropics thus far is limited and has not been evaluated. In this study, we estimated biomass across one year with both the Botanal® technique and a rising platemeter in Costa Rica, focusing on perennial ryegrass (*Lolium perenne*), Kikuyu (*Kikuyuocloa clandestina*), and African Stargrass (*Cynodon nlemfuensis*) pastures. Estimates of DM yield made with a plate meter were higher than with the Botanal® technique, especially in ryegrass (1,553 kg DM ha^{-1}), but also in Kikuyu (720 kg DM ha^{-1}) and Stargrass (683 kg DM ha^{-1}) pastures. Calibration of the plate meter with the regression equations developed in this study may improve accuracy with grasses grown in the tropics. Such straightforward techniques for biomass estimation could improve adoption by producers on tropical farms.

Keywords: ryegrass, Kikuyu, Stargrass, yield, platemeter, Botanal

Introduction

Livestock operations require accurate estimates of biomass yields as a means to allocate DM to grazing cattle. Livestock producers and technicians use estimates of the DM available in paddocks to make decisions related to stocking rates, rest periods, grazing intensity and nutritional balances. Many methods are available to estimate DM yield, which can be categorised as either destructive or non-destructive. Destructive techniques include the partial or total harvest of a significant area of the paddock or field, generally using machinery. Non-destructive methods extrapolate estimates from a small sample to a larger area.

The Botanal® is a non-destructive technique that combines hand-clipped and observational samples. Unfortunately, given that the clippings must be dehydrated for 48 h at 60 °C before an estimate can be calculated, many producers choose not to measure biomass with this technique. Plate meters, on the other hand, are devices that estimate biomass by applying pre-calibrated regression equations based on pasture height and density. Because plate meters provide data *in situ*, producers are more prone to use them as compared to other methods. However, the accuracy and precision of calibration equations of rising plate meters have not been evaluated with grass species in the tropics. In this study, we compare DM yield estimates using the rising plate meter and Botanal® techniques with ryegrass, Kikuyu, and African Stargrass in Cartago, Costa Rica.

Materials and methods

Dry matter yield of perennial ryegrass, Kikuyu and Stargrass, was measured at three dairy farms located at 2,800, 2,400 and 1,400 m elevation, respectively. In 18 pastures of each species, on the day before grazing, biomass was estimated using two techniques: (1) AgHub™ F300 electronic rising plate meter and (2) Botanal®. Plate meter measurements were taken first to avoid interference due to walking or clipping

during Botanal® sampling. The plate meter was used with the pre-calibrated equation regression 'y = 140 + 500x', and 30 - 40 observations were taken in paddocks with an average area of 3,140, 1,533, or 4,188 m^2 for ryegrass, Kikuyu or Stargrass, respectively.

During Botanal sampling, three levels of grass were collected that combined height and density (1 = low, 2 = medium, and 3 = high), hand-clipping each in a randomly placed 50 cm × 50 cm metal frame and drying in an air-forced oven at 60 °C for 48 h in the Research Centre for Animal Nutrition at the University of Costa Rica. In addition, 50 observations of level were taken in a zig-zag pattern. Then, the dry mass of the three levels were incorporated along with the observations, to estimate kg DM h^{-1} using the Botanal spreadsheet. Pasture slope was also measured with a nivelometer, and average sward height was measured with the plate meter.

To compare the relative accuracy between the two methods, the differences in estimated biomass were calculated. Regression equations were also developed for the three species based on the intercepts and slopes of Botanal estimates. These latter were estimated by weighting the average level in the paddock (50 observations) against the dry biomass from each level. Finally, the average level in each pasture was estimated using the calculated regression equations, and compared biomass estimates directly from the Botanal with those of the calculated regression outputs.

Results and discussion

Biomass estimates were higher with the plate meter than with the Botanal in all three species (Table 1). Ryegrass and Kikuyu pastures had similar yields with the Botanal method. Stargrass pastures exhibited the greatest yields with both methods. These results are similar to previous evaluations of biomass using the Botanal technique in ryegrass and Kikuyu pastures (3,360 and 3,517 kg DM ha^{-1}, respectively), but are greater in Stargrass (3,185 kg DM ha^{-1}) (Villalobos *et al.*, 2013). The differences found between the plate meter and Botanal techniques were greater in ryegrass as compared to Kikuyu and Stargrass (Table 1). Here we found a minimum of 13% difference between estimates in all species, suggesting that further calibrations are necessary to improve accuracy, because other studies note that 10% is a maximum acceptable difference relative to Botanal or other hand-clipping techniques (Sanderson *et al.*, 2001). The slope was steeper in ryegrass and Kikuyu paddocks than in Stargrass (Table 1). Swards were taller in Stargrass than in ryegrass or Kikuyu pastures.

Biomass estimates obtained with regression equations were similar to those obtained with the Botanal (Table 2); Stargrass had the greatest yield, followed by Kikuyu and ryegrass. The average differences between the regression equations and Botanal were greater for Stargrass followed by ryegrass and Kikuyu.

Table 1. Biomass yields of perennial ryegrass, Kikuyu and Stargrass estimated with two non-destructive methods in the highlands of Costa Rica.

Variable	Ryegrass		Kikuyu		Stargrass	
	Botanal	Plate meter	Botanal	Plate meter	Botanal	Plate meter
Average biomass (kg DM ha^{-1})[1]	3,368	4,922	3,493	4,462	5,399	6,083
Difference (plate meter-botanal)[2]	1,553 ± 217 (118-3,394)		720 ± 330 (-3,860-2,831)		683 ± 272 (-1,168-2,896)	
% difference[3]	46		21		13	
Slope in the pastures (%)	14.4 ± 3.0		11.9 ± 3.7		3.3 ± 0.9	
Sward height (cm)	31.5 ± 1.1		28.8 ± 0.8		40.0 ± 0.8	

[1] n = 18 paddocks per species.

[2] Standard error and range (min-max).

[3] (plate meter - botanal)/botanal × 100.

Table 2. Estimated biomass yields for perennial ryegrass, Kikuyu and Stargrass with an equation regression and their respective differences in the highlands of Costa Rica.

Variable	Ryegrass	Kikuyu	Stargrass
Regression equation for each species	y = -193 + 1,675x	y = -299 + 2,164x	y = 88.7 + 2,426x
Estimated biomass, kg DM ha^{-1}	3,400	3,519	5,311
Average difference (regression - botanal)[1]	32.1 ± 240 (-1,652-1,685)	25.7 ± 230 (-1,872-1,924)	-88.3 ± 217 (-1,715-1,532)

[1] Standard error and range (min - max).

Conclusion

In previous studies, researchers have found that non-destructive techniques using universal equations are likely to require calibration because grazing conditions vary among climatic regions. The existing equations for the plate meter had not yet been evaluated with grasses in the tropics but results from this study suggest that with calibration, this device could be beneficial for producers in estimating biomass in tropical pastures. The regression equations developed in this study can be uploaded to the rising plate meter and again compared to the Botanal method to further improve accuracy.

Acknowledgements

We thank the Research Office at the University of Costa Rica for funding this study.

References

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