VARIABILITY OF DRY MATTER PERCENTAGES OF BRASSICA FORAGES – GETTING FEED ESTIMATES RIGHT

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Abstract
Reaching target intakes of feed is important from both an animal health perspective, and in terms of optimising milk production. Intakes are based on the energy content of the feed, which in turn is based on the % dry matter (DM) of the crop. The DM of summer and winter forage brassicas can vary with crop type, age and crop component (e.g. leaf or stem). Therefore, the aim of this study was to compare the %DM of brassica forage crops with others in the same region, and with published values, to determine if average %DMs are adequate for calculating feed allocations. Dry matters were measured as part of a larger Sustainable Farming Fund project in the Central Plateau of the North Island. From the data collected it was found that the DM values measured for swedes were 20-30% lower than quoted values. In addition, DM varied with the age of crop, and with additions of nitrogen, but there was also variation between crops of similar age and variety. Using tabular values to calculate winter forage intakes for 100 cows resulted in a 20% overestimate of available feed. Therefore measuring DM is an essential step in calculating yields and allocation of feed. The result of getting these estimates wrong is cows not getting enough feed, and possibly not reaching the desired body condition score at calving, with consequences for animal health and future milk production losses.

Keywords
Swede, Kale, Turnip, Forage, Dry matter, Metabolisable energy

Introduction
The inaccurate allocation of feed has been found to be a key cause of cows not reaching target intakes (Judson and Edwards 2008). Feed allocation is calculated from herd requirements of metabolisable energy (ME). However, ME is reported on a kg dry matter (DM) basis and therefore correct estimates of both are important for getting feed estimates right. Forage brassicas are an important part of winter feeding systems in both the North and South Islands. Because ME does not vary as widely as %DM within brassica forage species (Westwood and Mulcock, 2012), correct estimation of %DM is of potentially greater importance for calculating accurate feed allocation. Dairy NZ's *Facts and Figures for New Zealand Dairy Farmers* (DNZ, 2010), and Beef and Lamb's *A Guide to Feed Planning for Sheep Farmers* (B & L, 2012) are two quick reference guides produced for farmers. The quoted %DM and ME values for kale, swedes and turnips vary and, together with other published information, a range of values emerges (Table 1). It is therefore not surprising that yield estimates are sometimes calculated using 10% DM, as a rule of thumb.

The overall aim of this Sustainable Farming Fund project (SFF 11/010) is to improve the efficiency of forage crop production in dairy systems on the pumice soils of the Central Plateau whilst minimising the environmental footprint. An unexpected but important issue that we came across when measuring yields was that the percentage dry matter content of the forage crops, and therefore yields, were often less than the farmers' expectations. Therefore, the aim of this study was to compare the %DM of brassica forage crops measured with others in the same region, and with published values, to determine if average %DMs are adequate for calculating feed allocations.

Table 1. Reported values of brassica dry matter (%DM) and metabolisable energy (ME; in MJ ME/kg DM).

Variety	Component	%DM	ME	Reference
		--------------- Swede -------------		
	Leaf	15	13.5	B & L, 2012
	Bulb	10		
	Whole	9-12	11.0-12.5	DNZ, 2010
	Whole	7.8-13.9	10.4-13.0	de Ruiter et al., 2007
	Whole	9.5-11.5	13.7-13.8	Westwood & Mulcock, 2012
		---------------- Kale ---------------		
	Whole	16	11.9	B & L, 2012
	Whole	11-15	11.0-13.5	DNZ, 2010
	Whole	11.2-16.0	8.8-13.7	de Ruiter et al., 2007
	Leaf	14.7-20.6	12.0	Westwood & Mulcock, 2012
	Stem		10.8	
		--------------- Turnip --------------		
	Leaf	13	14.1	B & L, 2012
	Bulb	9	12.9	
	Whole	9-11	12.0	DNZ, 2010
Barkant	Whole	9.8	11.9	Westwood & Mulcock, 2012
Green Globe	Whole	10.4	11.4	
	Whole	7.8-8.4	11.8-12.5	de Ruiter et al., 2007
	Stem	10.9	11.1	
		------------ Forage brassica --------		
Summer	Bulb	11		Litherland & Lambert, 2007
	Leaf	18		
Winter	Bulb	13.2		Litherland & Lambert, 2007
	Leaf	18.5		

Materials and methods

Yields and DMs were measured as part of a winter forage establishment trial on pumice soils near Mangakino; Central Plateau. Harvests were also measured on other SFF project member's farms in the area of Mokai, 24 km south east of Mangakino. Harvests of the winter forage trial were made approximately every four weeks after establishment using five 0.8 or 1 m^2 quadrats per treatment. The treatments had received either 83 (N_{83}) or 200 (N_{200}) kg N/ha. The final harvests were collected from a larger 2.25 m^2 area. Harvests made at members farms were collected from 0.8 or 1 m^2 areas, five replicates per paddock. Samples were analysed for %DM and MJ ME/kg DM was determined by Feedtech, Palmerston North, using Near Infrared Reflectance.

Results and discussion

Winter forage % DM over time

Measured DM in the establishment trial showed a general decreasing trend over successive monthly harvests (Figure 1). This trend was most pronounced in the swede bulbs, however the variation was substantial when measured at different times during development. Addition of fertiliser N decreased DM, but generally the N fertiliser effect became insignificant with time, depending on the forage and component (e.g. stem or leaf) (Figure 1).

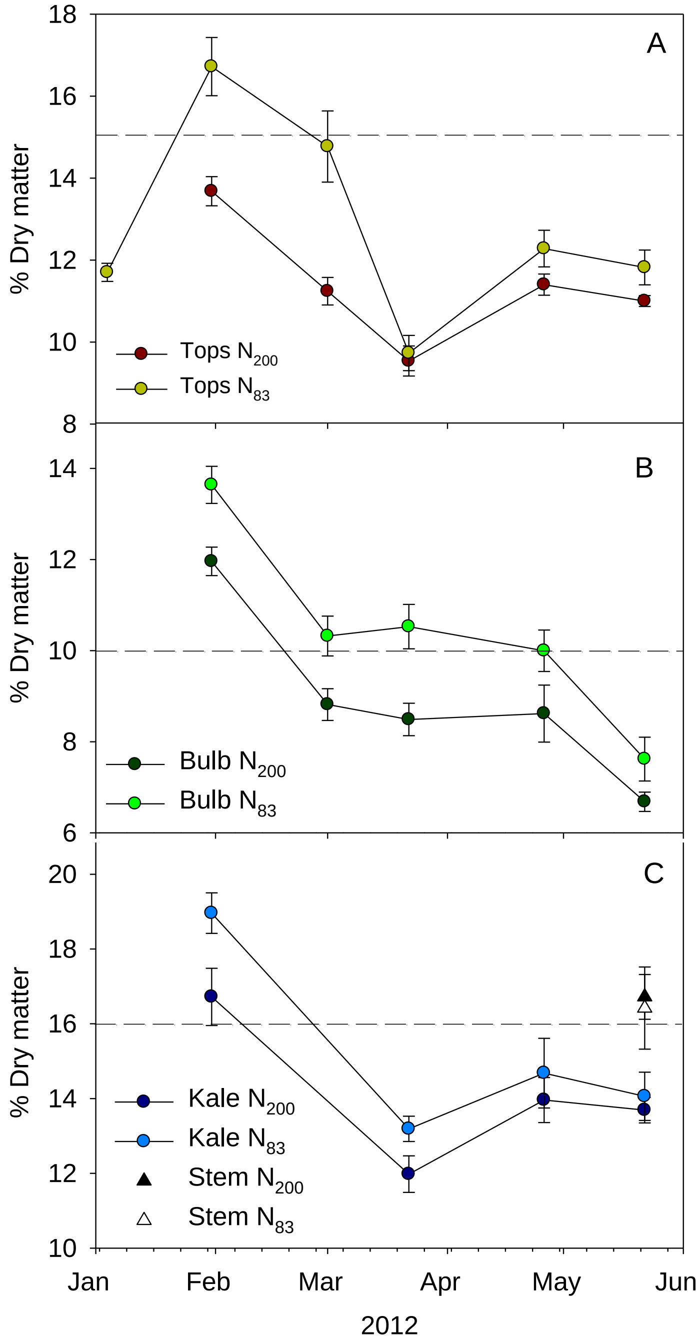

Figure 1. Percentage DM over time, in swede tops (A) and bulbs (B), and kale stem and leaf combined (C). For the final harvest of the kale leaves (circles) were separated from stem (triangles). Nitrogen treatments are either with an additional side dressing of N (N_{200}; 200 kg N/ha total), or with seedbed only (N_{83}; 83 kg N/ha total). Dashed lines represent the average values quoted for these crops (B & L, 2012). Error bars represent 1 SEM.

Final harvests - winter forage crops

There was substantial variation in %DM measured between crops of a similar age from the same area (Figure 2). However, because some of these crops were grown as a swede/kale mix, and others were grown as pure stands (Table 2) it is difficult to draw more than general conclusions. Kale stem DM ranged from 17-21%, which is above the range quoted in other studies in Table 1, while there was little variation in kale leaf DM. The DM measured in swede bulbs was consistently around 10% except for those at the trial site which were much lower (6.7%). Swede tops on the other hand, ranged from 11 to 15% DM, with the swedes grown in a pure stand having the greatest %DM (Table 2). More data is needed in order to better define how brassica growth in a mixed stand may affect DM, ME and other nutritional values.

To illustrate the consequences of differences in %DM, if feed breaks were calculated for 100 cows with a target offering of 10 kg DM/cow/day, the allocation, using measured DMs would be 940 m^2/day. If the DMs quoted by Beef and Lamb (B & L, 2012) were used, the yield would be overestimated by 20% and the break size would be 790 m^2/day, resulting in underfed stock.

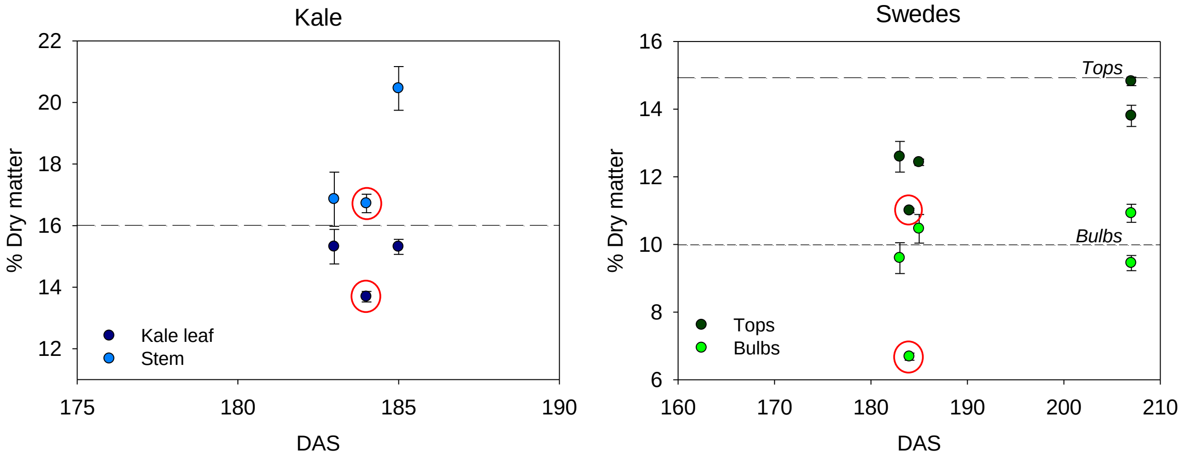

Figure 2. Percent dry matter of kale (left) and swedes (right) measured at final harvest with days after sowing (DAS). The dashed line indicates the average values (B & L, 2012). Red circles indicate the %DM measured on the trial site.

The ME in kale and swede leaves and tops was similar and ranged only from 11.3 to 12.5 MJ ME/kg DM (Table 2). Most of the variation in ME was found in either the stem or the bulb of kale and swedes. Although the ME of bulbs ranged from 12 to 15 MJ ME/kg DM, the swede bulb was where the greatest concentration of energy was found. Kale stem ME, however, was always lower than the leaf and ranged from 10-12 MJ ME/kg DM.

Table 2. Measured yields, dry matter (DM; %) and metabolisable energy (ME in MJ ME/kg DM) measured at the trial and neighbour farms (Pdk ID).

Crop	Yield	%DM		ME		Pdk ID
	t DM/ha	leaf	bulb/stem	leaf	bulb/stem	#
Kale	6[1]	15.3	20.5	12.1	11.6	1
Swede	2	12.4	10.5	11.6	14.0	
Kale	9	15.3	16.9	12.2	10.4	2
Swede	1	12.6	9.6	12.3	13.1	
Kale	8	13.7	16.7	12.4	9.6	3
Swede	3	11.0	6.7	12.5	11.9	
Kale	9	12.6		-		4
Swede[2]	12	14.8	10.9	11.7	14.9	5
Swede[2]	12	13.8	9.5	11.3	14.1	6

[1] + 1t weed DM/ha
[2]Pure stand

Final harvests - summer & autumn turnips

The DM measured at the time of final harvests of summer and autumn turnips, also varied widely, depending on cultivar and component. Two varieties of summer/autumn forage crops were grown: the earlier maturing Barkant and the later maturing Green Globe turnips. The yields of the summer and autumn crops ranged from 7 to 14 t DM/ha (Table 3). Dry matter percentage in the turnip tops ranged from 11 to 15, while the %DM in bulbs ranged from 8-14 and there was a significant difference ($P<0.05$) between and within cultivars. There was also a great range in the age of these crops with some in the ground for less than 80 days and others for more than 100 (Figure 3). It appears that DM content in Barkant turnips increased with age, and that these %DM were greater than the Green Globe variety of a similar age.

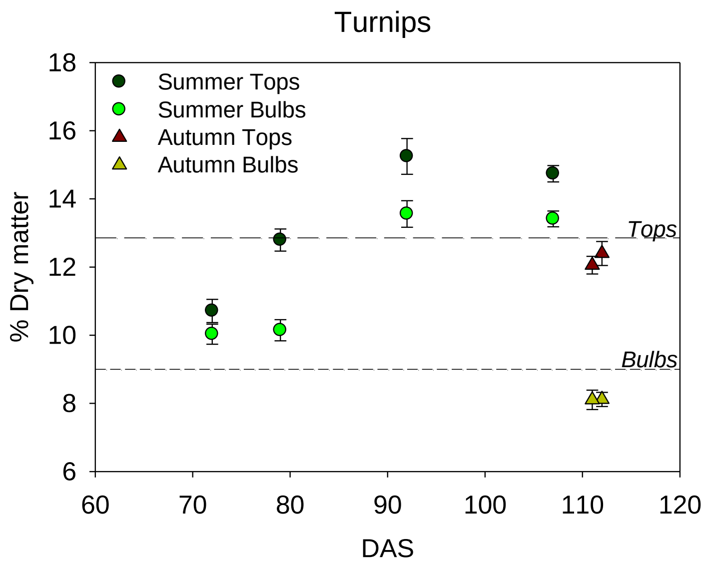

Figure 3. Percent DM of turnip forage crops (Summer = *Barkant*; autumn = *Green Globe)* measured at final harvest. . Days after sowing (DAS) is given on the x-axis and the dashed line indicates the quoted values (B & L, 2012). Bars indicate 1 SEM.

The turnips in paddock 4 had greater than average DM values (Table 3), and if the whole crop yield had been estimated using the 10% rule, the yield would have been underestimated by 30%. If the Beef and Lamb values used for the same example, the yield would have been 20% less. Looked at another way, if feed breaks were calculated as before with 100 cows and a target offering of 10 kg DM/cow/day, the break size calculated using the 10% rule would be 1230 m^2 and with Beef and Lamb values 1110 m^2, while the break size calculated with the actual %DMs was 850 m^2.

Table 3. Crop yields, dry matter (DM), and metabolisable energy (ME, in MJ ME/kg DM) of summer and autumn forage turnips.

Crop	**Yield**	**%DM**		**ME**		**Pdk ID**
	t DM/ha	**leaf**	**bulb**	**leaf**	**bulb**	**#**
Barkant	7	11	10	12.3	10.4	1
Barkant	14	15	13	12.8	10.3	2
Barkant	7	13	10	13.1	10.7	3
Barkant	12	15	14	12.9	11.0	4
Green Globe	8	12	8	11.7	10.0	5
Green Globe	10	12	8	12.4	10.3	6
lsd (5%)	*2.4*	*2*	*2*	*0.3*	*0.7*	

The ME measured at turnip harvest time ranged from 11.7-13.1 for turnip tops with less variation in the bulb (10.0-11.0 MJ ME/kg DM; Table 3). These values, again, are lower than the Beef and Lamb values of 14.1 and 12.9 for tops and bulbs, respectively (Table 1).

Discussion

While the measured percentage DM contents for kale were often within quoted ranges, the DM values measured for swedes were 20-30% lower than quoted values. Most of the %DMs of the brassica yields measured were greater than the 10% DM rule of thumb that is sometimes used to estimate yields. The measurements from our study and the values quoted in other studies show how variable these %DM values can be, and how difficult it is to give a reliable estimate of %DM without actually measuring it.

Our measurements of Barkant and Green Globe turnips seemed to show a difference in DM based on cultivar, but under more controlled conditions Westwood and Mulcock (2012) found no significant difference in the %DM for the same cultivars. It has also been shown that greater plant density in kale crops can lower the proportion of low quality stem (Drew et al. 1974) and therefore increase ME. In addition we have some evidence here that mixing crops, and rates of N applied may also change the %DM measured (Table 2). These findings highlight how variations in site fertility and weather conditions play a large part not only in determining yield, but also the %DM in that yield, and that the choice of crop and variety also influence quality and DM. Therefore, it is virtually impossible to accurately estimate the % DM of a crop from quick reference values.

This variation only adds to the complexity of calculating and managing dry matter intake through the winter. Within-paddock variation in yields and uncertainty around utilisation rates are not part of the scope of this paper, but will also invariably add to the error in estimating DM intakes. The result of getting these estimates wrong is cows not getting enough feed, and possibly not reaching the desired body condition score at calving, with consequences for animal health and future milk production losses.

Farmers need to understand the variability underpinning published reference values, and that they cannot replace actual measurements made in the field at grazing time. For farmers who want to maintain or improve body condition, an accurate estimate of the available standing feed, along with ensuring that break sizes are properly calculated, is vital.

Conclusions

- Dry matter changes with time and with additions of nitrogen
- Age of crop influenced DMs, but there was still variation between crops of similar age
- Farmers need to understand the variability underpinning published reference values and that using such values will likely result in over/under estimates of feed allocation.
- %DM variation adds to the complexity of calculating and managing dry matter intake, together with the uncertainty around utilisation rates.

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