A comparison of the intake of cows grazing swedes and kale and consequent condition score change.

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Abstract
The actual intake requirements of kale and swedes for maintenance and gain are not well defined for pregnant cows in winter. Farmer observations of cows grazing brassicas suggested that the winter feed requirements appeared much greater than those calculated using industry standards. Two balanced groups of dairy cows were grazed under similar management practices on a kale or swede brassica crop for a 5-week period during winter to estimate total energy intake and intake rate. Brassica intake rates did not differ significantly except for the period 5–24 hours after the commencement of grazing, when the swede group cows consumed more crop than the kale group ($P=0.042$). Body condition score change was higher ($P<0.05$) for the swede grazing group than the kale group. This was attributed to a higher overall consumption of crop and supplement, as estimates of total energy intake over the 5-week experimental period were 132 and 149 MJ ME/day for kale and swedes, comparing favourably with estimated energy requirements of 126 and 140 MJ ME/day. Allocation of feed has a much greater effect on changing condition score in cows than the type of crop fed.
Keywords: body condition score, energy intake, intake rate, kale, swedes.

Introduction
Dairy winter feeding systems in the South Island of New Zealand primarily utilise some form of brassica crop as the predominant feed source. Brassicas have an advantage over perennial ryegrass pasture during the colder months of the year by being able to maintain quality throughout the season (White *et al.* 1999), continue growing long after pasture growth ceases (Stephen 1973) and produce high yields over a relatively short period of time (Brown *et al.* 2007). They are a high energy and adequate protein source for dairy cows during winter, but are inherently low in fibre and as such should not make up more than 75% of the diet (Nichol *et al.* 2003). The crop is usually supplemented with a high fibre ration consisting of one or a combination of barley straw, pasture hay, baleage, and/or silage. To have a greater control on intake rates and crop utilisation cows are generally offered a daily ration *in situ* with supplement. In optimal situations this should provide opportunity for the cows to regain body condition prior to calving, which is a major goal in dairy farm systems during winter (Judson & Edwards 2008). Anecdotal evidence suggests that farmers do not always meet the target condition score gain when grazing dairy cows on crop during winter (Rugoho *et al.* 2010), and a survey suggested that some of this could be attributed to poor daily allocation of crop (Judson & Edwards 2008).

The actual intake requirements of kale and swedes for maintenance and gain are not well defined for southern New Zealand conditions. Farmer observations of cows grazing brassicas to achieve body condition score gains suggest that the winter feed requirements appear much greater than those calculated using industry standards. We investigated the energy intake and intake rate of swedes and kale by cows to determine if there was a difference in total energy consumption and consumption rates, and if that difference affected condition score change.

Methods
This experiment investigated the apparent intake, intake rate, body condition change and calculated energy requirements of cows grazing kale and swede crops. The experiment was situated on the Telford Rural Polytechnic teaching farm (Lat. 46.2923 S, Long. 169.7299 E), near Balclutha.

Feeding
Kale (*Brassica oleracea* 'Caledonian') was sown at 5 kg/ha under conventional cultivation while swedes (*Brassica napus* 'Invitation') were sown at 1.2 kg/ha in December 2009 by direct drilling into double sprayed pastures.

Crop yields were estimated prior to crop allocation using at least five randomly placed 1-m^2 quadrats. Crop and supplement apparent intake rates were measured on four separate days between days 193 and 202 of pregnancy at 0, 1, 3, 5, and 24 hours post-commencement of grazing using four 1-m^2 quadrats at each time. All crop, including leaf and bulb/stem, within the quadrat was collected, including material buried by trampling, at the 0, 1, and occasionally 3 hour periods depending on conditions. The 3 (occasionally), 5 and 24 hr samplings only included the bulb/stem, as any leaf at these stages was deemed to be inaccessible to the animals for harvesting due to trampling. Bulb/stem and leaf were washed, weighed, and dried separately to determine percentage dry matter, yield and utilisation rates of the individual components.

Hay and baleage bales contained 237 and 235 kg DM/bale, making up 50.2 and 49.8% of the supplement offered. Supplement apparent intake rates were calculated by measuring the dimensions of the supplement remaining in the feeders at each sampling time, taking into consideration the density of material as this changed depending on the feeding habit of the animals. Samples of both crops and supplements were tested for feed quality by near-infrared spectroscopy (NIR) analysis. The results from these analyses were then adjusted to account for the recovery of nutrients. The components of neutral detergent fibre (NDF), crude protein, ash and lipid were added together to determine the recovery of potential dry matter components of the sample. These values were adjusted to a standard 90% recovery of potential dry matter, and the metabolisable energy estimate was adjusted on the premise that components that were not recovered by the NIR would have a digestibility of 85%. Recoveries of potential dry matter and adjustment to metabolisable energy content are shown in Table 1.

Animals

Two hundred and fifty multiparous dry Friesian × Jersey dairy cows (liveweight = 467 kg ± 27.9 kg) were allocated into two groups evenly distributed for calving date (mean date = 30 August ± 12.8 days), body condition score (4.3 ± 0.57 BCS), age (5 ± 2 years) and production worth (101 ± 90 PW). Both groups were allocated approximately 8 kg DM/cow as either kale or swedes for a 6-week period, with an additional supplement allocation of approximately 4.5 kg DM/cow as equal proportions of baleage and hay. Cows were body condition scored at the commencement of the experiment at day 181 of pregnancy, and again at the end of the 5-week period at day 216 of pregnancy. Prior to the experiment commencing the cows formed part of a larger dairy herd that had been managed under standard dairy farm practice with lactation finishing in mid-May. The dairy cows were transitioned from a pasture-based diet to a crop-based diet over a 2-week period as per standard farm practice. Cows were monitored daily during moving, with any cows exhibiting poor health or low condition score being removed from the experiment and examined by a veterinarian. This experiment was approved by the AgResearch Invermay Animal Ethics Committee (Application number 12109).

Energy intakes and requirements

The total amount of feed offered to animals during the 5-week period was calculated by measuring the area of crop utilised using a GPS as well as counting the amount of supplement fed. This data was used in conjunction with the measured crop yields, utilisation rates, and feed tests to calculate the estimated energy intake during the 5-week period per group.

The energy requirement of pregnant cows (day 200; calf weight 38 kg) grazing on crop was estimated using the equations given by the Standing Committee on Agriculture and Resource Management (SCA 1990). Energy usage for activity included 1.8 km of horizontal walking/day and an eating time of 4.3 h/day as measured using GPS collars by Stevens *et al.* (2012). Vertical distance travelled was estimated to be 30 m based on topography, while ruminating time was calculated as equal to eating time. Energy required for body condition score gain (72 MJ ME/kg gain; 1 BCS = 31.5 kg LW) were added using current recommendations (DairyNZ 2012).

Statistical analysis

Crop yields and intake rates were analysed using a general ANOVA with the 4 separate days of apparent intake rate sampling treated as replicates. Body condition score change was analysed by using an unbalanced ANOVA.

Results

The swede crop yielded more than the kale crop (12 670 and 10 010 kg DM/ha respectively, P=0.045), though the kale crop had a greater amount of leaf than the swede crop (38 *cf.* 21%). The dry matter content of the crops was variable. The metabolisable energy concentration of the crops and supplements (Table 3) varied significantly, with the swedes having the highest values.

Larger break sizes were allocated to the kale group to offset the yield difference resulting in a similar on offer rate per cow per day of 8.45 and 8.38 kg DM (P>0.05) for the swede and kale groups respectively during the 4-day apparent intake measurement period. Apparent brassica intake rates per hour did not differ significantly except for the period 5–24 hours post-commencement of grazing, when cows offered swedes consumed more crop than those offered kale (P=0.042; Fig. 1). When the apparent intake rates were analysed as a percent of total consumed, cows offered kale consumed more than those offered swedes at 3 and 5 hours post-allocation (P<0.01; Table 2). By the end of the 24-hour period groups had consumed similar amounts of crop (P>0.05; Table 2). While total crop utilisation did not differ (Table 2), crop leaf utilisation rates were lower (P=0.034) for the swede crop (76%) than the kale crop (81%).

When considering the complete 5-week grazing period, the cows were offered a daily amount of crop of 9.68 and 8.29 kg DM/cow for the swede and kale groups respectively. Estimated crop consumption (Table 3) during this period using the recorded utilisation rates equates to 7.98 kg DM/cow/day and 7.13 kg DM/cow/day for the swede group and kale group respectively. Supplement on offer between the two groups during the same 5-week period was similar at 4.26 and 4.35 kg DM/cow/day for the swede and kale groups respectively. Estimated total intake over the 5-week period was 12.19 kg DM/cow/day for the swede group and 11.48 kg DM/cow/day for the kale group. Calculated energy intakes per day over the 5-week period using the relative intakes of each diet component were 149 and 132 MJ ME/cow/day for the swede and kale groups respectively.

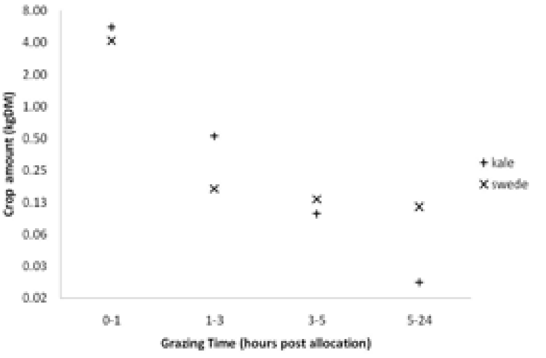

Figure 1. Kale and swede intake rates (log transformed axis) per hour for cows grazing during winter over a 24 hour period.

Body condition score did not differ between the two groups monitored at the start of the experiment, being 4.30 for both groups but did differ (P<0.001) at the end of the 5-week grazing period (4.67 and 4.45 for the swede and kale groups, respectively).

Discussion

Kale yield was lower than anticipated by the farmer

Table 1 Metabolisable energy measured by NIR, recovery of dry matter (Neutral Detergent Fibre + Crude Protein + Ash + Soluble Sugars and Starch) and metabolisable energy adjusted to a standard 90% recovery of dry matter.

	Measured energy (MJ ME/kg DM)	Recovery of dry matter (%)	Adjustment (MJ ME/kg DM)	Reported energy (MJ ME/kg DM)
Kale leaf	11.14	76.6	1.02	12.16
Kale stem	12.12	84.0	0.46	12.58
Swede leaf	11.08	79.2	0.83	11.91
Swede bulb	14.25	93.4	-0.26	13.99
Baleage	11.41	90.5	-0.04	11.37
Hay	7.77	85.3	0.36	8.13

Table 2 Utilisation, offered feed and apparent intake rates throughout a 24-hour period of crop and supplement being fed to pregnant, non-lactating dairy cows during winter as a percentage of total daily allocation. Number in parentheses is the kg DM/cow/day eaten.

	Crop		Supplement	
	Kale	Swede	Kale	Swede
Utilisation (%)	87	82	100	97
Offered (kg DM/cow/day)	8.4	8.5	3.4	5.1
Forage disappearance rate (% of total intake)				
by 1hr	77^a (5.6)	60^a (4.2)	32 (1.1)	39 (1.9)
by 3hr	92^a (6.7)	65^b (4.5)	32 (1.1)	39 (1.9)
by 5hr	94^a (6.8)	69^b (4.8)	74 (2.5)	73 (3.6)
by 24hr	100^a (7.3)	100^a (6.9)	100 (3.4)	100 (4.9)

^{a,b}Means within rows with different superscripts differ (P<0.01) which may have resulted in some underfeeding during the start of the winter period. This is not an uncommon occurrence, as indicated by a survey of kale feeding in Canterbury where it was found that around two-thirds of the herds appeared to be missing their kale intake targets (Judson & Edwards 2008). Swede yield was higher than the kale and considered to be around the anticipated yield that the farmer had budgeted for.

Crop intake rates were considerably higher in the first hour than had previously been reported elsewhere. Recent research on cows grazing kale demonstrated that cows allocated an allowance of 11 kg DM/cow/day had consumed over 78% of their daily intake by 3 hours and by 6 hours had essentially consumed all of their daily allocation (10.4 kg DM/cow) while cows offered an allowance of 14 kg DM/cow/day continued to graze and consumed a further 1.8 kg DM/cow (Rugoho *et al.* 2010). Two reasons that may have contributed to this higher rate are that the cows were allocated their crop and supplement at the same time in this experiment where as the cows in Rugoho's experiment were allocated their supplement one hour prior to the crop thus allowing many of the cows to partially fill their rumen. Secondly, the cows in this experiment were being offered a lower allocation of crop that may have resulted in a different feeding behaviour of the cows. Visual inspection of the cows after 3 hours found some cows with extended rumens and excess salivation which may indicate some digestive distress.

The differences in intake rates between the two crops may be a reflection of the ease of harvest of each crop. Kale is a very upright crop with all of its palatable biomass above ground and approximately 38% of its biomass as leaf compared with 21% leaf in the swede crop. The difference in proportion of leaf, combined with the measured utilisation rate of the crops meant that cows on kale consumed 2.6 kg DM as leaf/day compared with the 1.4 kg DM as leaf/day eaten by cows grazing swedes, with most of this consumed in the first hour. This accounts for most of the 1.4 kg DM difference between kale and swedes in the first hour. Swedes are a root crop with a proportion of its palatable biomass being buried in soil making harvesting of the remainder of the crop slower. These differences in agronomic features may have contributed to the slower intake rate on swedes.

Quality of the crops was generally within the range that has been previously reported in the literature (Agriseeds 2011; Keogh *et al.* 2009). The metabolisable energy content of brassicas measured using NIR has not been verified with standard pen feeding validation and so may be questioned. However, the soluble sugar and starch concentrations of the kale stem (31.8%) and the swede bulb (34.4%) help explain the very high estimates of ME. The further adjustment of the data to reflect a 90% recovery was used to help standardise the

Table 3 Crop intake, metabolisable energy (ME) of crop, and estimates of energy intake and use of cows grazing swedes or kale during five weeks in winter between days 181 and 216 of pregnancy.

	Kale			Swedes		
	Amount (kg DM/day)	ME (MJ/kg DM)	Intake (MJME/day)	Amount (kg DM/day)	ME (MJ/ kg DM)	Intake (MJ ME/day)
Leaf	2.56	12.2	31.2	1.55	11.9	18.4
Bulb/Stem	4.64	12.6	58.5	6.40	14.0	89.6
Baleage	2.17	11.4	24.7	2.12	11.4	24.2
Hay	2.18	8.1	17.7	2.14	8.1	17.3
Sum/Average	11.48	11.4	132.1	12.19	12.3	149.5
Estimated live weight (kg)		467			467	
Estimated liveweight gain (kg/d)		0.135			0.333	
Energy Requirements (MJ ME/day)						
Basal maintenance		55.3			55.3	
Activity		52.1			52.1	
Pregnancy (d 200)		8.2			8.2	
Gain		10			24	
Total energy required (MJ ME/day)		126			140	
Measured energy intake (MJ ME/day)		132			149	

data. The final estimates of energy intake and energy requirement were comparable (Table 3) and suggest that the approach taken has provided a useful estimate of the energy content of the components of the diet. If it was assumed that the overestimate of energy intake on the swedes was due to NIR error, a recalculation of the energy content of the swede bulb would suggest an ME content of approximately 12.9 MJ ME/kg.

Total estimated intake rates for the 5-week period indicated that the two groups received slightly different amounts of feed. The calculated energy requirement of a 467 kg cow at approximately 8 weeks before calving is 116 MJ ME/day for maintenance and pregnancy. Using the actual condition score changes of each treatment group an additional 10 and 24 MJ ME/day were required for the cows on kale and swedes respectively, making a total requirement of 126 and 140 MJ ME/day for kale and swede-fed cows. This compares favourably to the energy intakes of 132 and 149 MJ ME/cow/day estimated in this experiment. The small difference apparent may be due to an over-estimate of feed intake by this disappearance method, an over-estimate of the energy concentration of the brassicas, or an underestimate of the energy requirements of eating and ruminating. Rugoho *et al.* (2010) estimated eating times of kale that were approximately 36 minutes/kg DM, while those used here to estimate eating time were 21 minutes/kg DM. Interestingly, the reported intake rate for the supplement, that was offered at the beginning of each feeding period, was approximately 20 minutes/kg DM, similar to that reported here. Using the values of Rugoho *et al.* (2010) for eating and rumination would add an extra 7 MJ ME/day to the estimates of energy requirement. Overall the final calculated energy intakes in this experiment appear to be a good estimate of the actual energy available from brassica crops.

This experiment demonstrated that swedes were consumed at a slower rate than kale. However the consumption rate was still sufficiently high to do little to change the daily pattern of intake. This experiment also highlights the need for accurate calculation of energy requirements. Recent research by Mandok *et al.* (2012) also confirms that the maintenance requirement of dairy cows is 40% greater than that previously recommended, equating to a basal maintenance and pregnancy requirement of 106 MJ ME/day for this study. Further addition of energy requirements for gain, and activities such as extended eating, ruminating and walking would be required for cows in grazing situations such as those recorded in this experiment. Meeting BCS targets must take the full maintenance requirement of the cow into consideration. This research suggests that brassica crops can meet this need, and confirms the conclusion of Judson & Edwards (2008) that total crop allocation and crop utilisation must be appropriate.

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REFERENCES

Agriseeds 2011. Pasture and forage manual - The complete guide to pasture and brassica technology. New Zealand Agriseeds Ltd.

Brown, H.E.; Maley, S.; Wilson, D.R. 2007. Investigations of alternative kale management: production, regrowth and quality from different sowing and defoliation dates. *Proceedings of the New Zealand Grassland Association 69:* 29-33.

DairyNZ. 2012. Feed: Requirements of dry cows. http://www.dairynz.co.nz/page/pageid/2145861229/Requirements_of_dry_cows. Accessed August 2012.

Judson, H.G.; Edwards, G.R. 2008. Survey of management practices of dairy cows grazing kale in Canterbury. *Proceedings of the New Zealand Grassland Association 70:* 249-254.

Keogh, B.; French, P.; McGrath, T.; Storey, T.; Mulligan, F.J. 2009. Effect of three forages and two forage allowances offered to pregnant dry dairy cows in winter on periparturient performance and milk yield in early lactation. *Grass and Forage Science 64:* 292-303.

Mandok, K.S.; Greenwood, S.L.; Kay, J.K.; Crookenden, M.; Roche, J.R. 2012. Maintenance energy requirements of non-lactating, pregnant dairy cows. *Proceedings of the New Zealand Society of Animal Production 72:* 117-119.

Nichol, W.; Westwood, C.; Dumbleton, A.; Amyes, J. 2003. Brassica wintering for dairy cows: overcoming the challenges. Proceedings of the South Island Dairy Event (SIDE) Canterbury: 154-172.

Rugoho, I.; Gibbs, S.J.; Bryant, R.H.; Edwards, G.R. 2010. Intake and feeding behaviour of dairy cows grazing kale and grass at low and high allowances during winter. Proceedings of the 4th Australasian Dairy Science Symposium: 317-320.

SCA 1990. Feeding standards for Australian livestock. Ruminants. CSIRO Publishing, Melbourne.

Stephen, R.C. 1973. Winter forage crops in Canterbury. *Proceedings of the Agronomy Society of New Zealand 3:* 13-17.

Stevens, D.R.; Thompson, B.R. 2012. Intake, crop utilization and nitrogen outputs of cows wintering on swedes at two different allowances in Southern New Zealand. Australasian Dairy Science Symposium Conference Proceedings (in press)

White, J.G.H.; Matthew, C.; Kemp, P.D. 1999. Supplementary feeding systems. pp. 175-198. In: New Zealand Pasture and Crop Science. Eds. White, J. G. H.; Hodgson, J. Oxford University Press, Auckland.