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The effect of grazing pressure on intake and diet quality

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Abstract

The project aimed to identify the level of grazing pressure where intake is restricted and diet quality compromised. A pen study was conducted to determine whether faecal marker concentration can be used as a measure of changing forage intake. The results indicated that markers can be used to detect a fall in intake of forages when the recovery rate of markers is known. However, when complete recovery of markers is assumed a drop in intake can only be detected in diets with high passage rate.

The response of intake and diet quality to level of grazing pressure was studied during the dry and wet seasons in a savanna woodland in Queensland using graze down experiments to achieve high levels of utilisation over approximately 14-15 days. The animals preferred species that form dense patches of high digestibility and avoid species with tough stems. Pasture removal dropped when the pasture utilization was 24 and 31 % for the dry and wet season respectively. This reduction of intake occurred when the level of utilization of the preferred species was over 65 % in both seasons, suggesting that the level of pasture utilization at which intake drops depends on the proportion of preferred species in the pasture.

Executive summary

Grazing pressure can have substantial effects on animal performance via its effects on intake and/or diet quality. However, the relationship between grazing pressure and intake is not well understood. The project studied the response of intake and diet quality to level of grazing pressure. Such information will indicate the level of grazing pressure where intake is restricted and diet quality compromised. To accomplish this aim a reliable method was required to identify when intake starts to decline and quantitatively determine the extent of the decline. Therefore, a pen study was conducted to determine whether concentrations of a marker compound (either chromic oxide, alkanes or polyethylene glycol (PEG)) in the faeces can be used as a measure of changing food intake in cattle grazing tropical grasses. The results indicated that markers such as chromic chloride, PEG and alkanes can be used to detect initial changes in intake of high or low quality forages when the recovery rate of markers is known. However, when complete daily recovery of markers is assumed, intake can be reliably estimated only in diets with high passage rates (ie, high quality forages).

The response of intake and diet quality to level of grazing pressure was studied during the dry and wet seasons in a Eucalyptus savanna woodland near Charters Tower (QLD, Australia) with pasture containing *Aristida* spp. (wire grasses), *Bothriochloa ewartiana* (desert bluegrass), *B. pertusa* (indian couch), *Chrysopogon fallax* (golden beard grass), *Eragrostis lacunaria* (purple love grass), *E. sororia*, *Eriachne glauca*, *Heteropogon contortus* (black spear grass) and *Leptochloa divaricatissima*. The proportion of these species in the pasture varied from 8 to 16 % and 2 to 43 % for the dry and wet season respectively. Ten steers were used to graze down the pasture during a period of 15 and 14 days for the dry and wet seasons respectively. Daily forage intake was calculated based on faecal output estimated with markers (chromium, alkanes and PEG) and diet digestibility measured with faecal NIRS. Botanical composition and DM availability were assessed at the beginning of the experiments. Defoliation of individual plants was measured every second-day to provide a defoliation rate for each species and for the total pasture. The significance of the difference in chemical, structural and fracture properties between grass species was determined using ANOVA. Analysis of the effect of pasture utilization on estimated intake using markers was performed using analysis of variance (ANOVA) for repeated measurements. Starting and ending biomass were 2238 and 576 kgDM ha^{-1} for the dry season and 2108 and 848 kgDM ha^{-1} for the wet season. Consequently, the total pasture utilization at the end of the experiments was 74 and 60 % for the dry and wet season respectively. Despite its low proportion in the pasture *Bothriochloa pertusa* (Bp) was the preferred species with the highest levels of utilization between day 3 and 8 in both seasons. This species had the highest digestibility and basal area. Despite its high abundance in the pasture *B. ewartiana* was one of the least preferred species as its level of utilization at the end of the experiments was low in both seasons. The steers avoided *B. ewartiana* possibly due to its tough stems. The animals preferred species that formed dense patches of high digestibility and avoided species with tough stems. Pasture removal, estimated from herbage mass, decreased after day 7 when the total pasture utilization was 24 and 31 % for the dry and wet season respectively. The rate of decrease of forage intake estimated by markers did not follow the same pattern as pasture removal possibly due to the delay between a change in intake and its consequent change in faecal output caused by the low passage rate of the diet which was of relatively poor quality in both seasons. The decline of intake on day 7 occurred when the level of utilization of *Bothriochloa pertusa* was over 65% and this was consistent for both seasons. This suggests that intake drops when animals reach a certain level of depletion of the preferred species and are forced to graze the less preferred ones. This has important practical implications as the higher the proportion of preferred species in the pasture, the higher the level of overall pasture utilization above which intake drops.

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1 Background

Pasture utilization can have a substantial impact on animal performance via its effects on forage intake and/or diet quality. The effect of pasture utilization on forage intake can be studied through experiments of progressive defoliation where intake may decrease over the course of the experiments. As defoliation progresses, intake can be maintained at low level of pasture utilization as the animals can increase grazing time to compensate for the reduction in intake rate. When this compensatory mechanism is saturated, intake decreases rapidly. The project aimed to study the response of intake and diet quality to level of grazing pressure during the dry and wet seasons in a Eucalyptus savanna woodland in Queensland. Such information will indicate the level of grazing pressure where intake is restricted and diet quality compromised.

To accomplish this aim a reliable method to estimate the decrease in intake is required. Faecal markers work well in steady state condition to measure intake in grazing cattle (Penning 2004). Under non-steady state conditions, estimation of faeces output using markers can be inaccurate (Penning 2004). This is due to the time delay between a change in forage intake and the consequent change in faecal output. This time lag is expected to be longer with low quality diets due to their low passage rate.

Faecal markers travel through the digestive tract attached to the liquid and/or the particles. The passage rate of the liquid is faster that the particle, consequently, time lag of markers of the liquid face is expected to be shorter. Therefore it can be hypothesized that water soluble markers are able to detect a change in intake more accurately than water insoluble markers.

The aim of this pen study was to test two hypotheses: a) faecal markers can detect a change in food intake more accurately in high quality diets due to their fast passage rate b) water soluble markers (eg PEG) are able to detect a change in intake more accurately than markers (alkanes, $CrCl_3$) which attach to particulate matter due to their difference in passage rate.

2 Project objectives

1. Establish, via a pen study, the relationship of intake to faecal parameters, particularly the marker concentration curve such that the method detects changes in intake
2. Establish, via six field studies, the relationships between intake, grazing pressure and various pasture parameters
3. Develop a procedure by which faecal NIRS may be used in conjunction with these response curves to better inform forage budgeting and associated stocking decisions

3 Methodology

3.1 Comparison between faecal markers (Cr, alkanes and PEG) to detect a reduction in forage intake of cattle

3.1.1 Animals and feed

Ten steers of 292±16 kg were kept in individual floor pens (2 x 3 m) at James Cook University (JCU) Douglas Campus in Townsville, Australia. The animals were separated in two groups of five steers; group 1 and 2 received low and high quality buffel grass (*Cenchrus ciliaris)* hay respectively. The hay was offered *ad lib* to get 10% refusal from day 1 to 7. From day 8 to 14 the hays were offered at 90 % of the average eaten from day 5 to 7. Any refusals were weighed, and bulked per week for each animal. Each day from day 15 to 25 the amount of hay offered to each

animal was reduced by a set amount calculated as 8 % of the amount of hay offered over day 8 to 14. The animals were fed, 50 % of their daily allowance at 8am and 50 % at 4pm each day. A sample of each hay was taken every Monday, Wednesday and Friday. All samples were dried in a forced-air oven at 60 °C for 2 days

3.1.2 Faeces

From day 9 to 25 faeces were totally collected from the floor at 0800 hr each day for each animal. These samples were called BULK samples which were used to calculate the recovery rate of the markers. After faeces were removed in the morning, a sample of the first faecal output, which was called GRAB sample, was collected and used to estimate intake. After collection, faecal samples were weighed, mixed well, sampled into an aluminium tray, dried in a forced-air oven at 60 °C for 5 days and ground through a 1-mm sieve.

3.1.3 Markers

On day 5 each animal was dosed with two slow release capsules of alkane (Captec Ltd, Auckland, New Zealand). Each capsule contained 4 g n-dotriacontane (C32) and 4 g n-hexatriacontane (C36) and was designed to release 200 mg of both markers each day for a period of approximately 20 days. The day of depletion of the capsules was identified by the sudden decrease of the total faecal output of alkanes of bulk daily samples. From day 5 to 24 each animal was offered at 9 am 450 mg of $CrCl_3.6H_2O$ (equal to 87,82 mg Cr) and 90 g of PEG-6000 (polyethylene glycol-6000) dissolved in 300 ml of molasses. During the same period, on different days, the animals received daily doses of 1g of alkanes of different chain lengths dissolved in the molasses, along with the other markers. On days 4, 10, 16 and 23 they received alkane C26, on days 6, 12 and 18 they received alkane C28 and on days 8, 14 and 20 they received alkane C30.

The mean retention time (MRT) for the whole gastrointestinal tract was calculated using C26, C28 and C30 according to Thielemans et al. (1978) as

$$MRTGIT = \frac{\Sigma tiCidti}{\Sigma cidti}$$

with Ci=marker concentration in the faecal samples from the interval represented by time ti (hours after marker administration) and dti=the interval (hours) of the respective sample

$$dti = \frac{(t_{i+1} - t_i) + (t_i - t_{i-1})}{2}$$

3.1.4 Chemical Analyses and Measurements

The concentration of Cr in faecal samples was determined using the method described by de Vega and Poppi (1997). The concentration of PEG and estimation of diet digestibility in faecal samples was determined using NIRS (Coates, 2004). A detailed description of the analysis of faecal samples for the alkanes is given in Dove and Mayes (2006.).

The equation to estimate forage intake using markers (Cr, Alkanes and PEG) was:

$$\text{Intake } (kg.day^{-1}) = \frac{\text{Faecal output } (kg.day^{-1})}{(1 - \text{diet digestibility estimated using faecal NIRS})}$$

$$\text{Faecal DM output } (g.day^{-1}) = \frac{\text{Weight of marker given per day } (g.day^{-1}) \times \text{recovery rate of the marker}}{\text{Concentration of marker in faeces } (g.g^{-1} \text{ DM})}$$

$$\text{Recovery rate of the marker} = \frac{\text{Total marker output (g.day}^{-1}\text{ or g.experiment}^{-1}\text{)}}{\text{Total weight of marker given (g.day}^{-1}\text{ or g.experiment}^{-1}\text{)}}$$

Total marker output (g.day^{-1}) = marker concentration (g.g^{-1} faeces) x total faecal output (g.day^{-1})

3.1.5 Statistical analysis

The rate of decrease of actual intake and estimated intake using markers and actual faecal output was analysed by analysis of variance for repeated measurements using GenStat.

3.2 Field studies for Desert bluegrass during the dry and wet season

3.2.1 Site details

The study was undertaken at the Wambiana property near Charters Towers during the dry season of 2009 (September – October)and wet season of 2010 (March – April). The site was fenced to provide one equilibration paddock and one trial paddock. The area of the trial paddock was 2.25 hectares with 46 and 12 trees per hectare of ironbark (*Eucalyptus melanophloia*) and box eucalyptus (*Eucalyptus brownii*) respectively. The plant species composition and forage availability of the equilibration paddock was similar to that of the trial paddock. The animals were kept for 4 days in the equilibration paddock and then moved into the trial paddock for another 15 and 14 days for the dry and wet season respectively.

The area of the trial paddock during the dry season was adjusted so that the level of pasture utilization stayed under 10% during the first 3 days. To achieve 70% utilisation by day 16 the fence was moved on day 3, and on day 8 six new animals were introduced. This pattern of pasture utilization was designed to have a good description of the relationship between pasture utilization and forage intake of the test animals as level of pasture utilization increased. During the wet season, only the area of the paddock was halved on day 5 but the number of animals was not modified.

The same paddock was used for both seasons. Nevertheless, due to heavy rains from cyclone Ului, the lower portion of the paddock was flooded on March 21st 2010 before moving the animals into the experimental paddock (March 24th) and this area had to be removed from the experiment. The paddock grazed during the wet season represented approximately 60 % of the dry season paddock. Due to heterogeneity in plant species distribution over the paddock area, this reduction in paddock size induced a reduction in the number of plant species that could be monitored from 9 species during the dry season to 6 species during the wet season.

3.2.2 Pasture assessment

The plant community was constituted by *Aristida* spp. (wire grasses), *Bothriochloa ewartiana* (desert bluegrass), *B. pertusa* (indian couch), *Chrysopogon fallax* (golden beard grass), *Eragrostis lacunaria* (purple love grass), *Eragrostis. sororia*, *Eriachne glauca*, *Heteropogon contortus* (black spear grass) and *Leptochloa divaricatissima*. These species were arrenged in five distintive plant comunites. One of them constituted by *Aristida* spp., *Chrysopogon fallax*, *Eragrostis lacunaria* and *Heteropogon contortus. Another plant comunity was constituted by Eriachne glauca*, and *Leptochloa divaricatissima.* The other three plant comunities were constituted by single species of *Bothriochloa ewartiana, B. pertusa* and *Eragrostis. Sororia*. All plant comunities were organized in distintive patches scatered within the paddock.

E sororia, *E. glauca* and *L. divaricatissima* were mainly located in the lower portion of the paddock which was flooded in March 2010. They were assessed during the dry season grazing period only, converse to the 6 other species which were assessed in both periods.

The pasture assessment was done using the following protocol:

1- The trial paddock was walked to identify patches of the plant communities which were marked with two star pickets, measured and assessed with a 50 x 50 cm quadrat by walking a transect between the star pickets stopping every 5 steps. Plant basal perimeter, stem height (seed heads) and leaf height were measured for each plant within the quadrat. A total of 180 and 70 quadrats were assessed during the dry and wet season respectively. Using this data the basal area per hectare per species was calculated. Dry weight was used to rank species composition.

2 –For each plant species there were plants of different heights. Therefore, three plants of each height category for each species were cut in three equal strata. Prior to cutting; the diameter and height of each stratum were measured so that the area and volume occupied by each stratum could be calculated. Each stratum was divided into leaves and stems. The plant parts of each stratum were then counted, weighed (wet), dried at 65 ˚C and weighied (dry). The digestibility and crude protein content of leaves and stems of each stratum were analyzed using NIRS. The tensile strength of 3 fresh leaves and stems per stratum was measured using a portable device. The bulk density per stratum and initial forage availability per species was calculated using the data collected in step 1 and 2:

Initial forage availability (kg DM ha^{-1})= ∑ initial forage availability of each species (kg DM ha^{-1})

Initial forage availability of each species (kg DM ha^{-1})= ∑ basal area of each height category (m^2 ha^{-1}) x forage availability of each height category per unit of basal area (kg DM m^2)

3- Plants to be assessed during the trial period were located along the transects and marked with numbered metal pegs. Seventy-five plants (25 for each height category) of each major species was assessed during the dry season and 90 plants (30 of each height category) during the wet season. A total of 675 and 546 plants were assessed during the dry and wet season respectively.

4- The marked plants were assessed before cattle were introduced and then every second day during the defoliation period. Before cattle were introduced plant height, leaf height, and basal perimeter of each plant were recorded. During the defoliation period the height of defoliated leaf and stems using a ruler and the percentage of defoliated area for visual estimation were recorded every two days. Forage availability (per species and total) was calculated using the data collected in step 1, 2 and 4. Pasture removal was then calculated as the difference in forage availability between consecutive days, results are presented as percentage of the body weight of the animals.

3.2.3 Livestock

The same ten Brahman cross steers of 318 (± 18) kg and 410 (± 25) kg were used for the dry and the wet season respectively. Animals were weighed at the start and at the end of each period (equilibration and trial period). The animals received dry lick *ad libitum* with 30 % and 10 % urea, for the dry and the wet season respectively. Composition of lick can be seen at the manufaturer web site (http://www.stocklicktrading.com.au/default.asp)

The first day of the equilibration period, each animal was dosed with an alkane cattle capsule (Argenta®) and moved to the equilibration paddock to allow faecal marker output to reach equilibrium. During the equilibration and trial period each animal (except 1 animal which received molasses without markers) received a daily dose of 97.57 mg of Cr as $CrCl_3 6H_2O$., and 90 g of PEG 6000 with 200 g of molasses. After the animals had eaten the molasses with the markers a

daily grab faecal sample was taken. All faecal samples were oven dried at 65˚C after being frozen the day of collection and stored in zip clip bags. The samples were then ground through a 1 mm screen and analysed using faecal NIRS to estimate dietary crude protein (CP)%, non-grass % and DM digestibility from the equations derived by Coates (2004) and concentration of PEG 6000 (Landau et al., 2002).

3.2.4 Daily forage intake

The following equation was used to estimate daily intake:

$$\text{Intake (kg.day}^{-1}\text{)} = \frac{\text{Faecal output (kg.day}^{-1}\text{)}}{(1 - \text{diet digestibility estimated using faecal NIRS})}$$

$$\text{Faecal DM output (g.day}^{-1}\text{)} = \frac{\text{Weight of marker given per day (g.day}^{-1}\text{) x recovery rate of the marker}}{\text{Concentration of marker in faeces(g.g}^{-1}\text{ DM)}}$$

The recovery rate of the markers was assumed to be 100 %.

3.2.5 Statistical analysis

The significance of the difference in chemical, structural and fracture properties between grass species was determined using ANOVA. Analysis of the effect of pasture utilization on estimated intake using markers was performed using analysis of variance (ANOVA) for repeated measurements using GenStat.

4 Results and discussion

4.1 Comparison between faecal markers (Cr, alkanes and PEG) to detect a reduction in forage intake of cattle

4.1.1 Diet

There was a significant difference in quality between hay types for all nutritional variables ($p \leq 0.001$) (Table 1). The leafy hay had a higher digestibility and protein content and lower retention time, NDF and ADF than the stemmy hay. As a result the forage intake was greater for the leafy hay.

The retention time of alkanes C26, C28 and C30 increased as forage intake decreased (Figure 1). Digestibility was expected to increase due to the longer retention time caused by lower intake. However, digestibility decreased after day 16 posibibly due to molasses relative increase in diet, particularly with leafy hay, but the value was only approximately 3% units well within normal variation (Figure 2). This decrease in digestibility resembles the reduction of digestibility that occurs during progressive defoliation of pastures as the animals graze an increased amount of plant parts of lower quality such as stems. Therefore, the results of this study are relevant for progressive defoliation studies.

Table 1. DM Digestibility, mean retention time (MRT), chemical composition and intake of leafy and stemmy hay used for the experiment

	Digestibility (%)*		MRT†	NDF	ADF	Crude protein	DM Intake‡	DDM Intake‡
	In vivo	NIRS	hours	%	%	%	% LW	% LW
Leafy hay	59	59	34	63	40	11	2.3	1.4
SE§	1.6	0.2	2.3	0.8	0.6	0.4	0.12	0.04
Stemmy hay	53	53	45	72	48	6	1.7	0.9
SE§	1.8	0.1	1.4	0.6	0.3	0.2	0.02	0.03

*average digestibility from day 5 to 7 from faecal bulk samples(n=5)
†average MRT of C26, C28 and C30 dosed from day 4 to 9 from bulk samples (n=15)
‡average actual intake from day 5 to 7 (n=5)
§SE = standard error of the mean

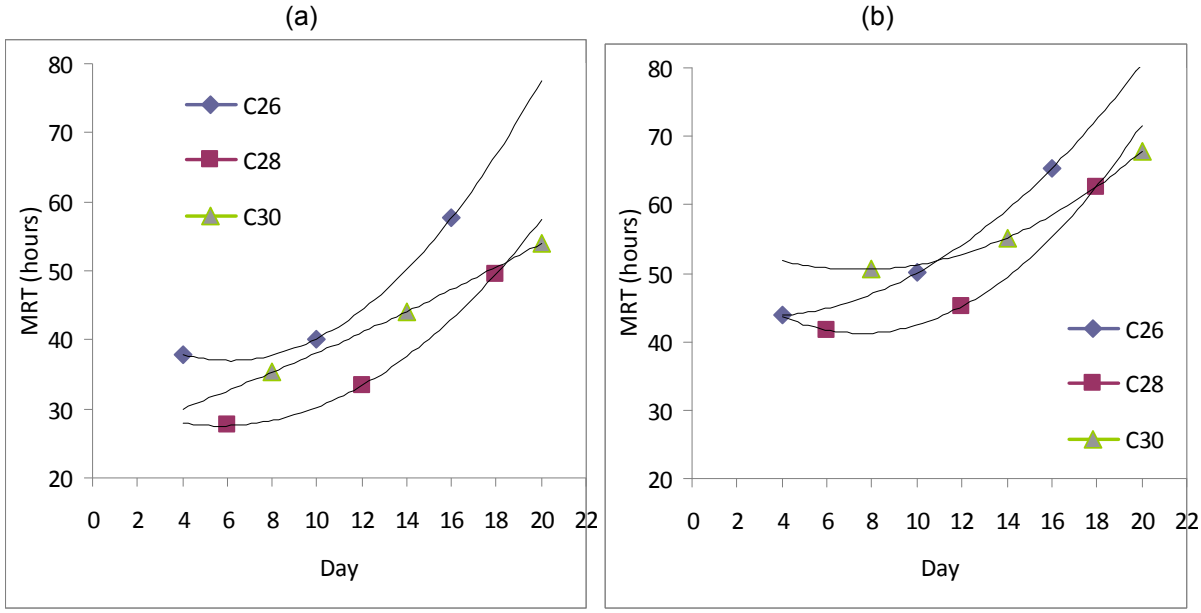


Figure 1. Mean retention time (MRT, hours) of alkanes (C26, C28 and C30) dosed every 6 days on steers fed with leafy (a) and stemmy (b) buffel grass hay (days of the experiment).

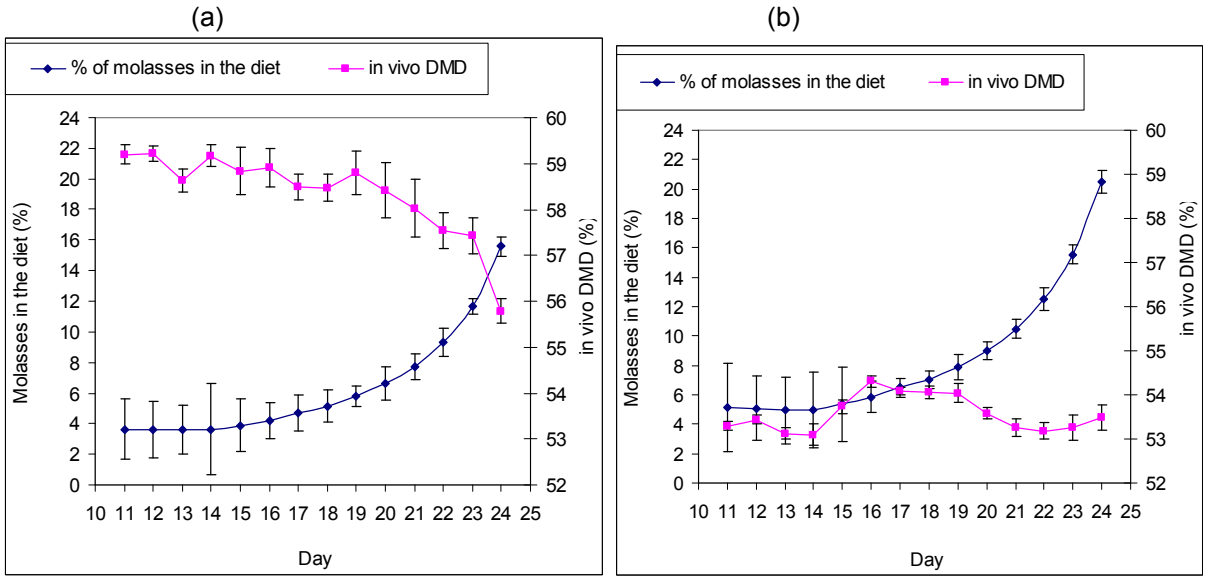


Figure 2. Estimated *in vivo* digestibility (%) using NIRS and percentage of molasses in the diet on steers fed with leafy (a) and stemmy (b) buffel grass hay (days of the experiment).

4.1.2 Recovery rate of markers

The overall recovery rate of markers, calculated from the total amount of marker given and recovered during the entire experiment (day 5 to 30), varied from 93 to 99 % indicating a satisfactory recovery of all markers (Table 2). However, the recovery rate, calculated from the daily amount of marker given and recovered, decreased with the reduction of intake for all markers (Figure 3). This was possibly due to increasing retention time which caused an increasing delayed of the dosed markers to appear in the faeces (Figure 4).

Unlike chromium and PEG, C32 showed a recovered rate higher than 100 % when intake was maintained at 90 % of voluntary intake. This difference between markers was due to the way the recovery rate was calculated. The daily dose of chromium and PEG was known as the animals were given a known amount of marker every day. The daily release of C32 from the capsules was calculated dividing the content of C32 of the capsules by the numbers of days the capsules released the marker. This average rate of release for the whole experiment did not take into account the likely decreased of the rate of release due to the reduction of intake over time. Consequently, the calculated average rate of release of C32 could have been lower than the actual rate when intake was maintained at 90 % of voluntary intake resulting in an overestimation of the recovery rate during this period. However, this hypothesis is not supported by previous studies where there was no effect of level of feeding on release rate of alkanes (Dove *et al* 2002) As expected the recovery rate of alkanesC26, C28 and C30 increased with the length of the molecule (Figure 5).

Table 2. Overall recovery rate of markers. Calculation based on total amount of marker given and recovered during the entire experiment (day 5 to 30)

	Recovery rate (%)			Realise rate (mg.day^{-1})
	Chromium	C32	PEG	C32
Leafy hay	98	100	97	435
SE§	6.9	1.2	4.1	5.7
Stemmy hay	95	93	93	389
SE§	3.1	2	3.9	8.1

§SE = standard error of the mean

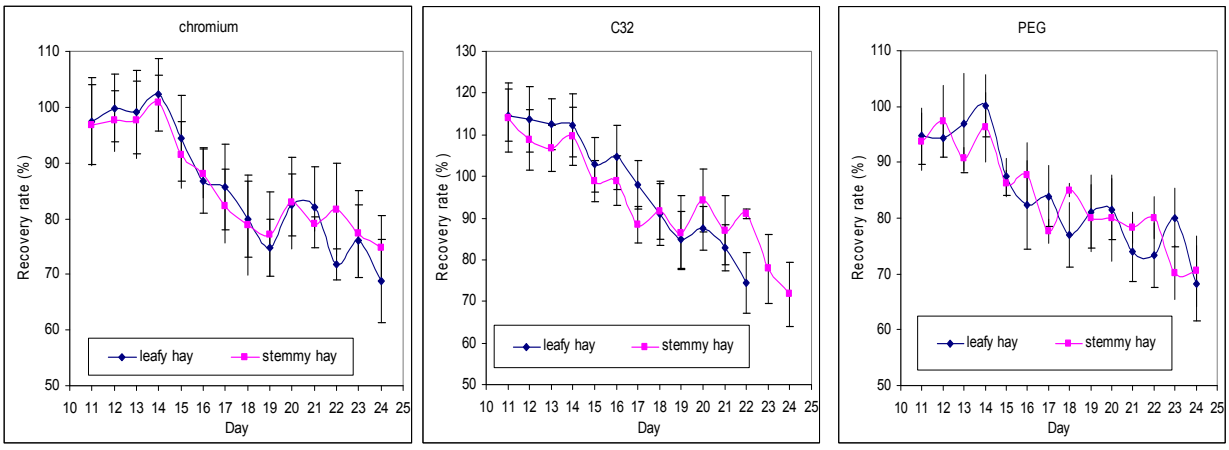


Figure 3. Daily recovery rate of faecal markers on steers fed with leafy (a) and stemmy (b) buffel grass hay(days of the experiment).

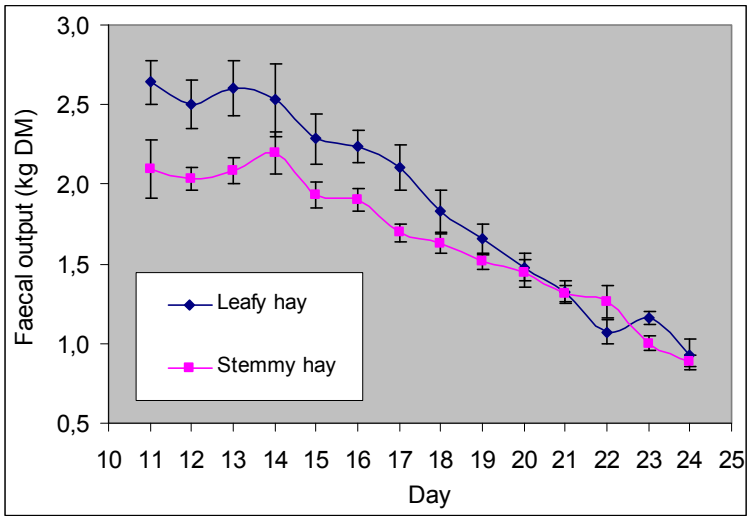


Figure 4. Daily faecal output of steers fed with leafy and stemmy buffel grass hay (days of the experiment)

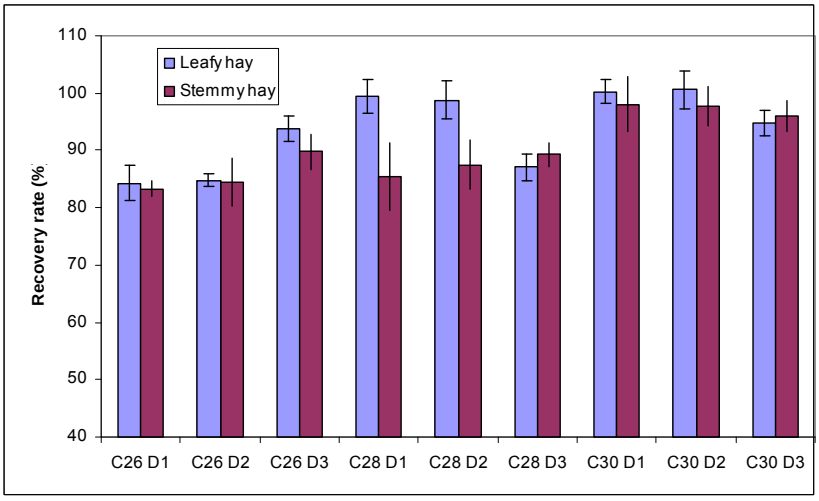


Figure 5. Recovery rate of alkanes (C26, C28 and C30) dosed every 6 days on steers fed with leafy and stemy buffel grass hay. D1, D2 and D3 = dose 1,2 and 3.

4.1.3 Reduction in forage intake

Figures 5 and 6 show the reduction of actual and estimated intake using total faecal collection and faecal marker concentration of grab samples. The results shown in Figures 5 and 6 were calculated using actual marker recovery rate or assuming 100 % of recovery rate. The alkane capsules stopped releasing alkanes on day 22 and 25 in animals fed with leafy and stemmy hay. Accordingly the data was analysed until day 21.

When actual recovery rate was used for the calculations there was no significant difference in the accumulative rate of decrease of forage intake between actual intake and intake estimated by markers from day 15 to 20 for both hay types ($P \geq 0.05$). These results indicate that, when the recovery rate of markers is known, an initial decrease in forage intake can be detected using chromium chloride, PEG or alkanes. However, to measure the recovery rate of markers in grazing studies it is necessary to collect all the faeces using faecal bags. The use of faecal bags has a number of disadvantages and avoiding its use could be beneficial if the rate of decrease of intake could be detected assuming a recovery rate of 100 %.

If a recovery rate of 100 % is assumed an initial decrease in intake of high quality forage (leafy hay here) can be detected using chromium chloride, PEG or C32 as the difference in the accumulative rate of decrease of intake between actual intake and intake estimated using markers was not significant from day 15 to 20 ($P \geq 0.05$). However, in low quality forage (stemmy hay here) an initial decrease in forage intake cannot be detected by any marker as the rate of decrease of intake estimated using markers was significantly lower than the rate of decrease of actual intake ($P \leq 0.05$). This difference in the ability of the markers to detect a decrease in intake between forage qualities can be explained by the slower passage rate of the stemmy hay. This slow passage rate causes an increase in the time delay between a change in forage intake and the consequent change in faecal output. As a result the difference between actual and estimated intake using actual faecal output increased as intake decreased with the low quality forage (Figure 2) but not with the high quality forage (Figure 7).

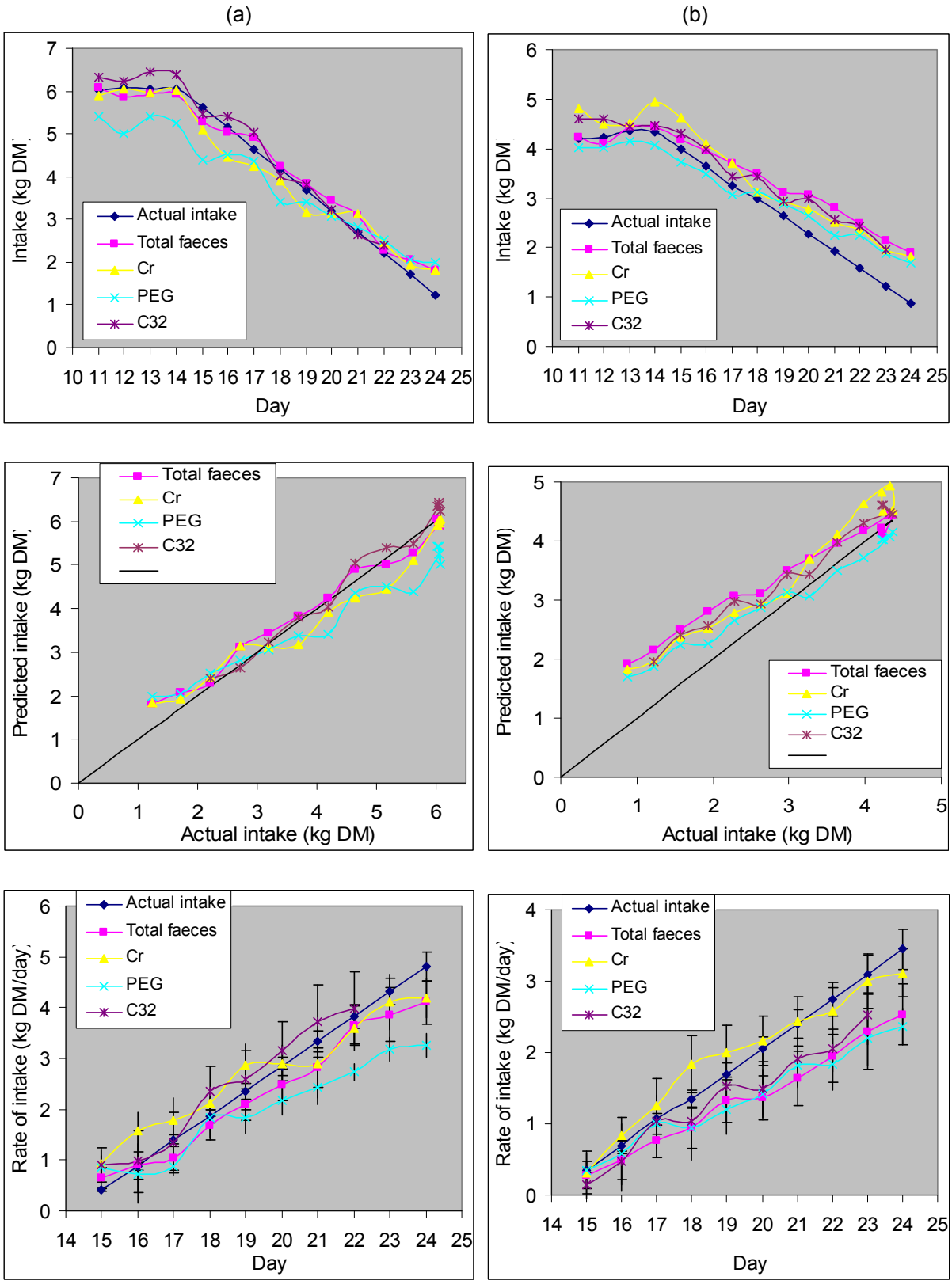


Figure 6. Actual and predicted intake (kg DM) and its rate of decrease (kg DM.day^{-1}) calculated using actual recovery rate of markers (Cr, PEG and alkane C32) on steers fed with leafy (a) and stemmy (b) buffel grass hay (days of the experiment)..

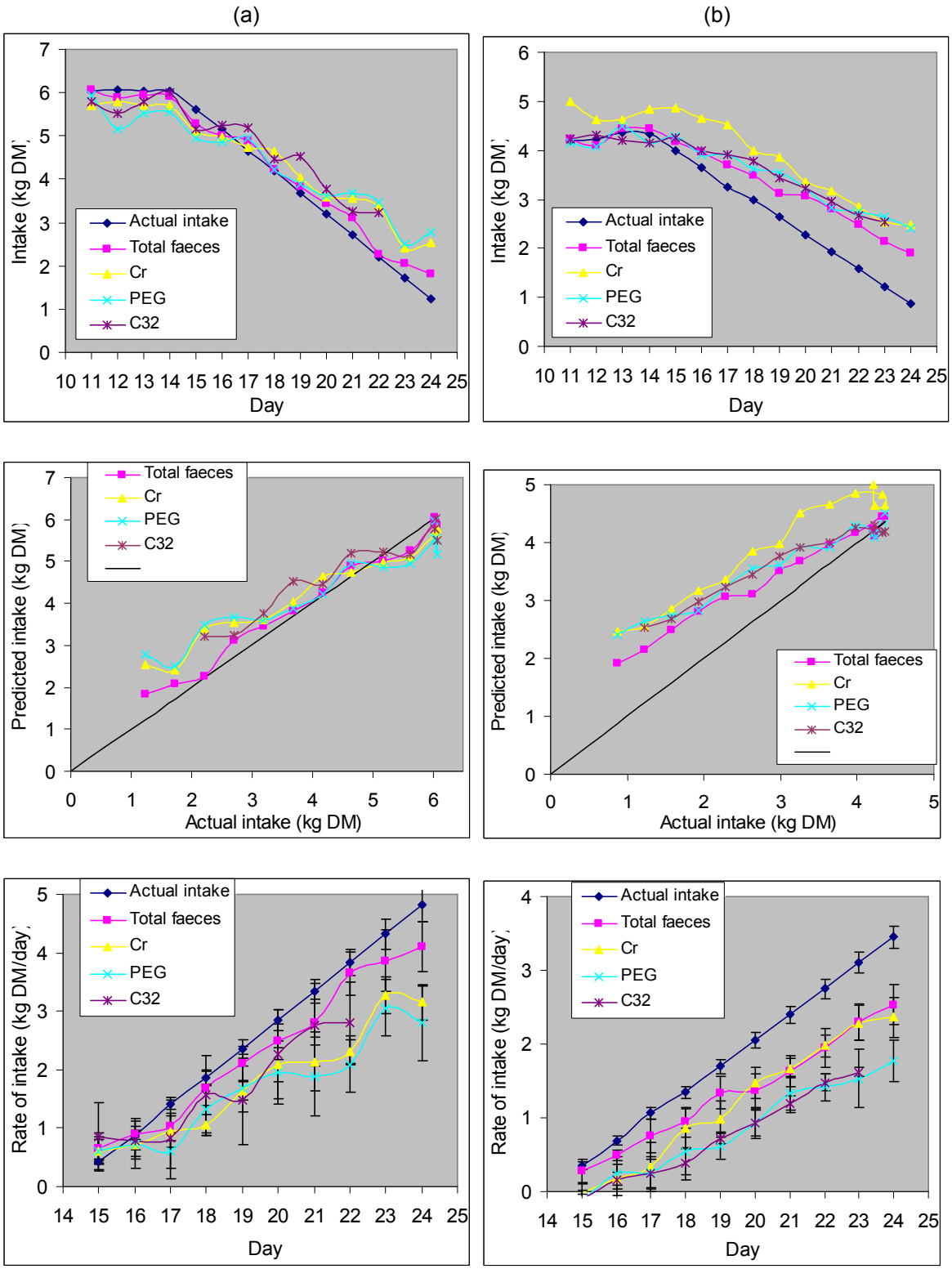


Figure 7. Intake (kg DM) and its rate of decrease calculated (kg DM.day^{-1}) assuming 100% recovery rate of markers (Cr, PEG and alkane C32) on steers fed with leafy (a) and stemmy (b) buffel grass hay (days of the experiment)..

4.2 Field studies for Desert bluegrass during the dry and wet season

4.2.1 Pasture composition and level of utilization

Starting and ending biomass were 2238 and 576 kgDM ha^{-1} for the dry season and 2108 and 848 kgDM ha^{-1} for the wet season. Inital forage availability per species is shown on table 3. The proportion of species in the pasture varied from 8 to 16 % and 2 to 43 % during the dry and wet season respectively (Figure 8).

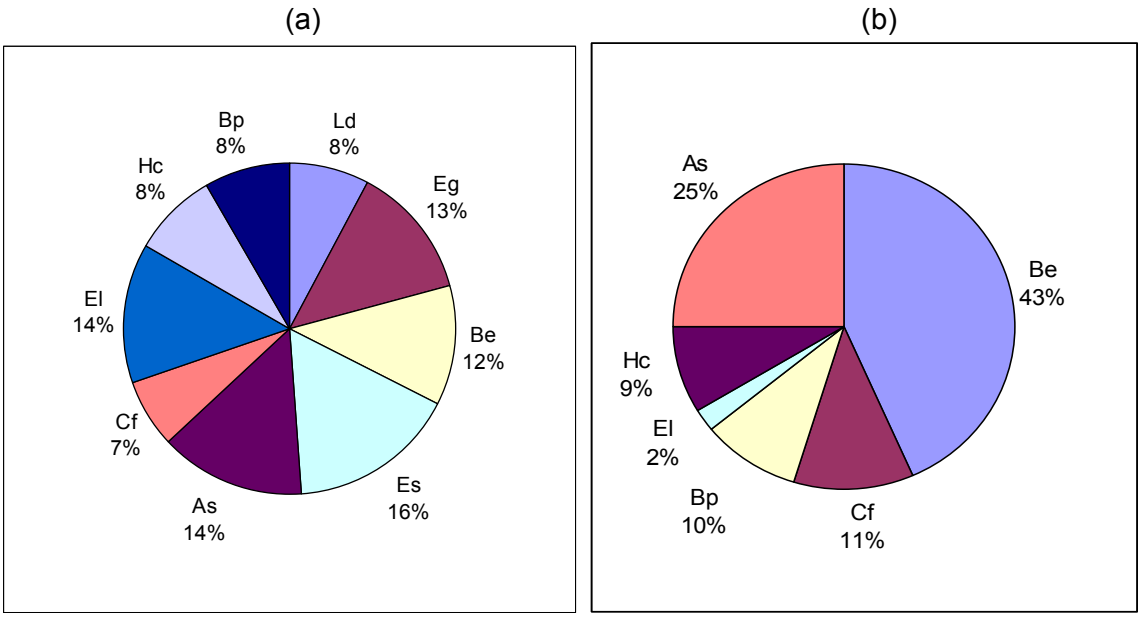


Figure 8: Pasture composition as percentage of total dry matter availability during (a) dry and (b) wet season. *Aristida spp*. (As) (wire grasses), *Bothriochloa ewartiana* (Be) (desert bluegrass), *Bothriochloa pertusa* (Bp) (indian couch), *Chrysopogon fallax* (Cf) (golden beard grass), *Eragrostis lacunaria* (El) (purple love grass), *Eragrostis sororia* (Es), *Eriachne glauca* (Eg), *Heteropogon contortus* (Hc) (black spear grass), *Leptochloa divaricatissima* (Ld).

Table 3: Initial forage availability (kg ha^{-1})

	Dry season	Wet season
Aristida spp.	313	527
Bothriochloa ewartiana	262	911
Bothriochloa pertusa	189	201
Chrysopogon fallax	153	241
Eragrostis lacunaria	304	48
Eragrostis sororia	368	
Eriachne glauca	293	
Heteropogon contortus	183	180
Leptochloa divaricatissima	173	
Total	2238	2108

The total pasture utilization at the end of the experiments was 74 and 60 % for the dry and wet season respectively. With increasing pasture utilization, the defoliation rate of grasses varied between species. Despite its low proportion in the pasture *Bothriochloa pertusa* (Bp) was the

preferred species with the highest levels of utilization between day 3 and 8 in both seasons (Figure 9). This species had the highest digestibility and basal area (P≤0.05)(Table 4). Despite its high abundance in the pasture *B. ewartiana* was one of the least preferred species as its level of utilization at the end of the experiments was low in both seasons. The steers avoided *B. ewartiana* possibly due to its tough stems. However other studies suggest that there has been preference for desert blue over Indian couch (eg, EcoGraze). This indicates that preference is context dependent and generalisations can be difficult.

Table 4: Plant description, STR: stem tensile resistance (N), DMD: dry matter digestibility (%), LSR: leaf/stem ratio, BA: basal area ($cm^2.m^{-2}$) area of the base of the plant.

	Dry season				Wet season			
	STR	DMD	LSR	BA	STR	DMD	LSR	BA
Aristida spp.	38	48	0.46	155	22	49	0.35	200
Bothriochloa ewartiana	182	47	0.28	386	76	47	0.55	760
Bothriochloa pertusa	33	50	1.37	777	37	53	0.35	320
Eragrostis lacunaria	8	50	0.75	110		52	0.54	58
Eragrostis sororia	42	48	0.58	169				
Eriachne glauca	25	48	0.36	162				
Heteropogon contortus	94	47	0.70	90	50	52	0.33	301
Leptochloa divaricatissima	47	49	0.65	232				

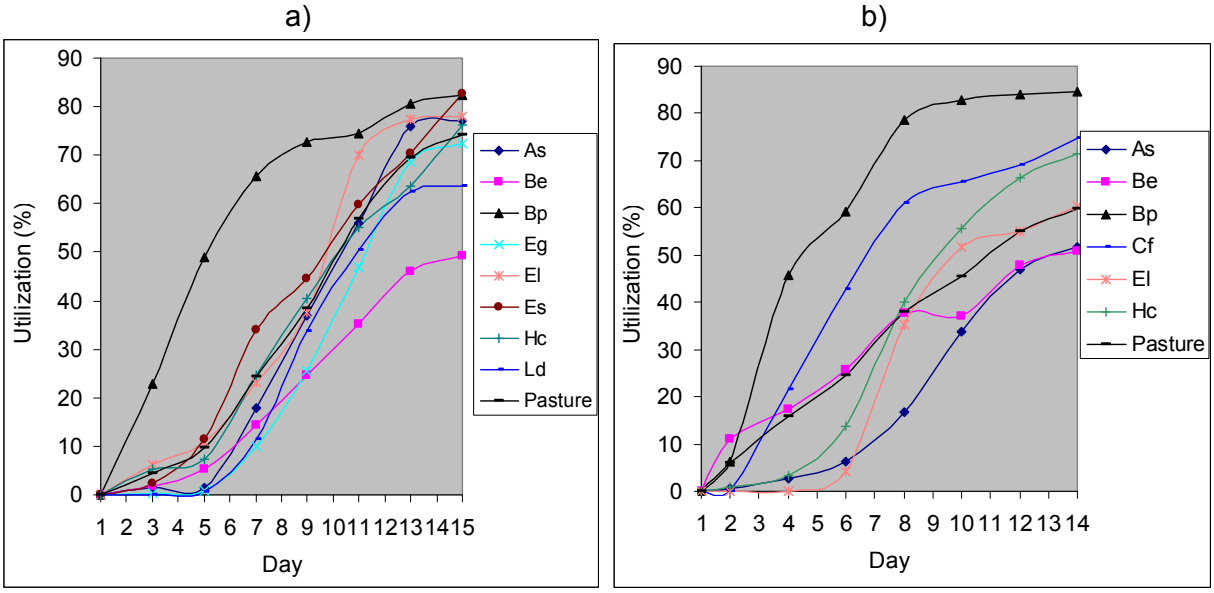


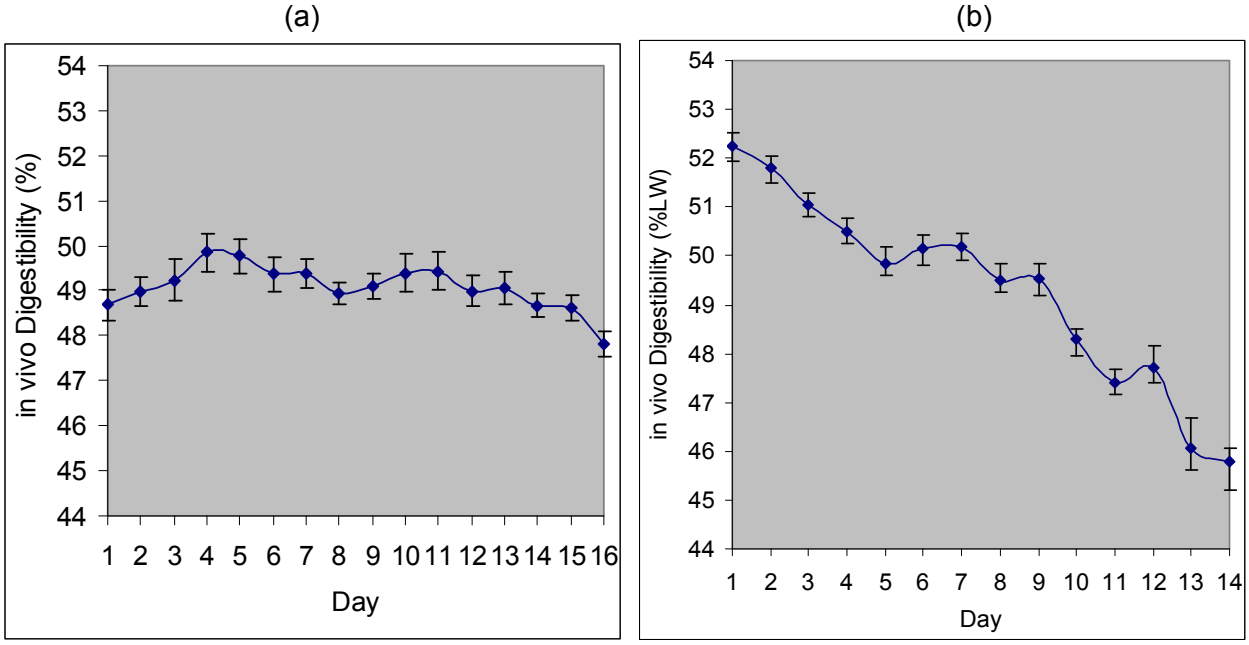
Figure 9: Level of utilization of grass species (days in the trial paddock) during the (a) dry and (b) wet season. *Aristida spp*. (As) (wire grasses), *Bothriochloa ewartiana* (Be) (desert bluegrass), *Bothriochloa pertusa* (Bp) (indian couch), *Chrysopogon fallax* (Cf) (golden beard grass), *Eragrostis lacunaria* (El) (purple love grass), *Eragrostis sororia* (Es), *Eriachne glauca* (Eg), *Heteropogon contortus* (Hc) (black spear grass), *Leptochloa divaricatissima* (Ld).

Pasture utilization, diet quality and forage intake

During the dry season, there was a sharp reduction of pasture removed after day 7 (Figure 10) when the pasture utilization was 24 %. In contrast, forage intake estimated by markers did not change due to the possible low passage rate of the diet which caused a delay between a change in intake and its consequent change in faecal output. These results confirm the results of the pen study that showed that none of the markers was able to detect a drop in intake of the stemmy hay, with an in vivo digestibility of 53 %, due to its low passage rate. It is likely that the passage rate during the dry season was even lower as the estimated in vivo digestibility varied between 48 and 50 % (Figure 10).

Similarly, during the wet season the pasture removal, dropped after day 7 (Figure 10) when the pasture utilization was 31 %. Consistently, there was also a significant reduction of forage intake estimated by markers. The decrease of forage intake was lower than the decrease of pasture removed, particularly from day 7 to 11, possibly because of the low passage rate of the diet which was of low quality.

The decrease of intake on day 7 occurred when the level of utilization of *Bothriochloa pertusa* was over 65 % in both seasons. This suggests that intake drops when animals deplete the preferred species and are forced to graze the less preferred ones. We believe that this has important practical implications as the higher the proportion of preferred species in the pasture the higher the level of overall pasture utilization at which intake drops.



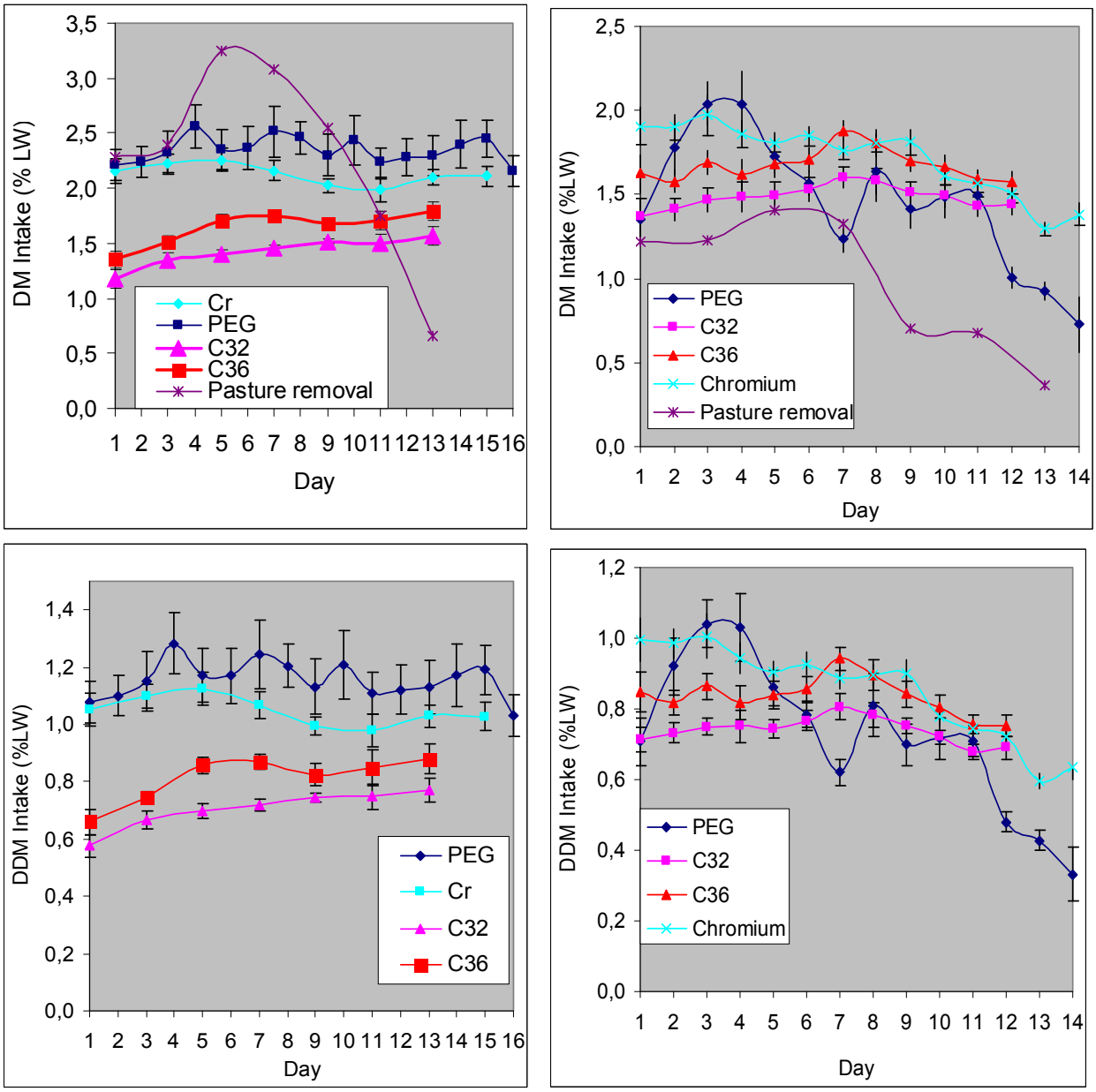


Figure 10: *In vivo* DM digestibility (using faecal NIRS), DM forage intake and digestible DM forage intake estimated using assumed 100% recovery rate of polyethylene glycol (PEG), chromium (Cr) and alkanes (C32 and C36), as markers in nine steers grazing down the plant community during the (a) dry and (b) wet season(days in the trial paddock).

5 Conclusions and recommendations

5.1 Comparison between faecal markers (Cr, alkanes and PEG) to detect a reduction in forage intake of cattle

Markers such as chromium chloride, PEG or C32 can be used to detect initial changes in intake if the recovery rate of the makers is known. However if a recovery rate of 100 % is assumed faecal markers can be used to identify a drop in intake only for high quality forage with high passage rate. As such it may not be useful for dry season pasture.

5.2 Field studies for Desert bluegrass during the dry and wet season

The animals preferred grass species that form dense patches of high digestibility and avoid species with tough stems.

Pasture intake declined when the pasture utilization was 24 and 31 % for the dry and wet season respectively. This reduction of intake occurred when the level of utilization of the preferred species was over 65 % in both seasons. This suggests that the level of pasture utilization at which intake declines depends on the proportion of preferred species in the pasture

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