End of Project Report

ARMIS NO. 4277

EFFECTS OF CONCENTRATE DISTRIBUTION PATTERN ON THE PERFORMANCE OF FINISHING STEERS FED SILAGE

Author

M.G. Keane

Teagasc acknowledges with gratitude the support of European Union Structural Funds (EAGGF) in financing this research project.

GRANGE RESEARCH CENTRE,
Dunsany,
Co. Meath
ISBN 1 901138 887
December1998

Teagasc
Agriculture and Food Development Authority

EUROPEAN UNION
European Agricultural Guidance and Guarantee fund

Contents

INTRODUCTION

The present economic level of concentrate supplementation for finishing steers offered silage *ad libitum* is in the range 4 to 7 kg per head daily depending on factors such as concentrate costs, type of animal being finished and anticipated carcass price (Keane, 1998). Concentrates are normally fed at a flat rate throughout the finishing period either as one or two discrete meals per day or as part of a mixed ration. In recent years, mainly because of the need to hold cattle until specific dates to collect premia, the practice of varying the level of concentrates throughout the finishing period has developed. Feeding a lower level early on prevents animals being finished before their eligible premia dates, and then if they are not finished as the eligible premia date approaches, the level of concentrates is increased to permit rapid disposal after the retention date has passed.

As animals mature and fatten, their rate of gain declines even when energy intake remains constant. This could have an adverse effect on meat quality as there is evidence that a declining rate of gain before slaughter predisposes to poorer quality meat. Furthermore, Mediterranean markets in which Irish beef processors are showing increasing interest require carcasses with muscle which is light red in colour and fat which is white in colour. These colour traits are more likely when animals are fed a high level of concentrates towards the end of the finishing period.

The objectives of the present study were 1) to compare different distribution patterns of supplementary concentrates for finishing steers, and 2) to ascertain if there were interactions between concentrate feeding pattern and breed type.

EXPERIMENTAL

Two experiments were carried out. In experiment 1, 88 finishing steers (40 Charolais x Friesians (CH) and 48 Friesians (FR)) 19 months of age and 523 kg initial mean liveweight were blocked on weight and assigned within breed type to 4 supplementary concentrate treatments with grass silage *ad libitum*. The treatments were:

1. No concentrates, silage only (NONE)
2. Concentrates fed at a flat rate of 5 kg per head daily(FLAT)
3. Concentrates fed on a stepped basis of 2.5, 5.0 and 7.5 kg per head daily, respectively for each consecutive one-third fraction of the fattening period (STEP)
4. Silage only initially and concentrates *ad libitum* over the second half of the finishing period (ADLB). The intention was to feed the same total quantity of concentrates in Treatments 2, 3 and 4.

Concentrate composition (g/kg) was 915 rolled barley, 70 soyabean meal and 15 minerals/ vitamins. The animals were accommodated in a slatted floor shed in 8 pens of 5 (CH) or 6 (FR) animals each. Thus, there were two pens or replicates per feeding treatment and breed type sub-group. Feed intakes were recorded for 4 days per week. The duration of the finishing period was 126 days at the end of which all the animals were slaughtered together in a commercial abattoir. After slaughter, cold (hot weights x 0.98) carcass weights were recorded, carcasses were graded according to the EUROP scale, and kidney plus channel fat was weighed. Samples of feed were taken regularly for analysis and the animals were weighed regularly throughout the finishing period.

In Experiment 2, 60 animals (36 CH and 24 FR) were used. Initial age and weight were similar to in Experiment 1. The animals were assigned to 3 of the treatments used in Experiment 1 (NONE, FLAT and ADLB) with CH only in the NONE treatment. The supplementary concentrate (same formulation as in Experiment 1) level was 6 kg per head daily and the duration of the finishing period was 147 days. Slaughter and carcass assessment were as in Experiment 1.

RESULTS

Because Experiment 1 was a fully balanced 4 x 2 factorial and there were few important interactions, the data are presented as main effects with significant interactions indicated. In addition, for comparison with Experiment 2 where the data are presented as interactions because of its unbalanced design, the data for Experiment 1 are also presented as interactions in Appendix Tables 1, 2, 3 and 4.

Feed analysis is shown in Table 1. Mean silage analysis for Experiment 1 was dry matter (DM) 212, crude protein (CP) 144, *in vitro* dry matter digestibility 722, ash 92, lactic acid 130, and NH_3N (g/kg total N) 18 g/kg and pH 3.70. Corresponding values for Experiment 2 were 164, 182, 748, 98, 85 and 35 g/kg and 3.93. Mean concentrate composition was DM 876, CP 136, ash 34 and oil 15 g/kg.

Table 1. Analysis of feeds used in Experiments 1 and 2.

	Silage		Concentrate
	Experiment 1	Experiment 2	
Dry matter (DM) (g/kg)	212	164	876
Crude protein	144	182	136
Dry matter digestibility	722	748	--
Ash	92	98	34
Lactic acid	130	85	---
NH_3N (g/kg N)	18	35	---
pH	3.70	3.93	---
Oil	---	---	15

Composition is given on a dry matter basis for silage and on a fresh basis for concentrates

EXPERIMENT 1

Feed Intakes: Feed intakes of the animals are shown in Table 2. Most differences between the feeding treatments were significant. Because concentrates were introduced and increased gradually the animals did not always consume their exact target allowance in a particular period. Mean silage intake for NONE was 6.84 kg/day (12.4 g/kg mean bodyweight (BW)). Feeding 5 kg (4.38 kg DM) concentrates per day depressed silage intake by 1.65 kg DM/day, so total DM intake was increased by 2.73 kg. Total silage and concentrate intakes for the FLAT and STEP treatments were almost identical. Mean total silage intake for these two treatments was 242 kg DM less than for NONE for a mean concentrate intake of 513 kg DM. Because of the difficulty in predicting intake when the animals were fed concentrates *ad libitum*, the ADLB group consumed less total silage but more total concentrates than the FLAT and STEP groups. Total DM intake for the ADLB group was 1189 kg compared with a mean of 1134 kg for the FLAT and STEP groups.

Furthermore, the ADLB animals had a concentrate proportion of 0.542 in their DM compared with a value of 0.453 for the FLAT and STEP groups. There were significant differences between the breeds in intake at all times with FR having higher silage but lower concentrate intakes than CH. Total silage intake was 15% higher for FR but total concentrate intake was 7% higher for CH. Overall, DM intake was 6% higher for FR. There was an interaction between feeding treatment and breed type for concentrate intake which was due to the fact that when concentrates were offered *ad libitum* in the ADLB treatment, CH consumed more than FR. In the other treatments concentrate allowance was fixed and in all treatments FR consumed more silage than CH.

Table 2. Effects of concentrate distribution pattern and breed on feed intake (kg dry matter/day) of steers (Experiment 1).

Period (days)		Feed (F)				Breed (B)			Significance		
		NONE	FLAT	STEP	ADLB	CH	FR	s.e.d.[1]	F	B	FxB
0-42	Silage	7.61[a]	4.78[b]	5.83[c]	7.67[a]	6.13	6.81	0.246	***	*	NS
	Conc.	---	2.96	1.65	---	1.07	1.23	0.001	***	***	NS
42-84	Silage	6.62[a]	4.96[b]	5.08[b]	5.01[b]	5.16	5.68	0.036	***	***	***
	Conc.	---	4.38[a]	4.15[b]	3.44[c]	3.17	2.82	0.025	***	***	***
84-126	Silage	6.74[a]	5.11[b]	4.27[c]	1.31[d]	3.86	4.85	0.029	***	***	***
	Conc.	---	4.38[a]	6.40[b]	10.70[c]	5.52	5.22	0.201	***	***	NS
0-126[2]	Silage	862[a]	618[b]	622[b]	544[c]	616	707	20.4	***	***	NS
	Conc.	---	499[a]	528[b]	645[c]	437	407	9.8	***	NS	**

[1]For n = 24; [2]Total for experiment
Values with different *superscripts* **are significantly different (P<0.05) in this and subsequent tables. Conc. = concentrates**

Liveweights and Gains: Liveweight gains of the animals are shown in Table 3. In the absence of concentrates, liveweight gains were initially low suggesting that there may have been a loss of gut fill after the animals moved on to their experimental treatments. Afterwards, liveweight gain on silage only increased with time. On the FLAT treatment, liveweight gain decreased with time from 1145 g/day over the first 42 days to 848 g/day in the period from 84 to 126 days. Liveweight gain increased with time on the STEP treatment with increasing level of concentrates. Liveweight gain on the ADLB treatment was low initially when the animals were receiving silage only, it increased thereafter when concentrates were introduced and was very high at the end when the animals had concentrates *ad libitum*. Mean daily liveweight gain for the experimental period as a whole was 363 g/day and 1012 g/day for the silage only and the three concentrate supplemented groups. There were no differences between the concentrate supplemented groups, respectively. In the early stages of the experiment CH had higher gains than FR but this was reversed towards the end with the result that overall gain was similar for the two breed types.

Table 3. **Effects of concentrate distribution pattern and breed on liveweight gains of steers (Experiment 1)**

	Feed				Breed (B)			Significance	
	NONE	FLAT	STEP	ADLB	CH	FR	s.e.d.[1]	F	B
No. animals	22	22	22	22	40	48			
Daily gains(g)									
0-42 days	126[a]	1145[b]	714[c]	226[a]	724	455	65.4	***	**
42-84 days	341[a]	912[b]	1119[c]	1002[bc]	910	745	43.7	***	***
84-126days	621[a]	848[b]	1264[c]	1876[d]	943	1326	41.2	***	***
0-126 days	363[a]	968[b]	1033[b]	1035[b]	859	842	42.7	***	NS

[1]For n = 22. There were no significant interactions

Liveweights are shown in Table 4. They reflect the liveweight gains already described. After 42 days, the FLAT group were significantly heavier than NONE and after 84 days all three concentrate supplemented groups were significantly heavier than those fed silage only. This was also the case at the end but there were no differences between the concentrate supplemented groups themselves. There was no significant difference in liveweight between the breed types at any time.

Table 4. **Effects of concentrate distribution pattern and breed on liveweights of steers (Experiment 1)**

	Feed (F)				Breed (B)			Significance
Liveweights at(kg)	NONE	FLAT	STEP	ADLB	CH	FR	s.e.d.[2]	F
Initial	522	523	523	523	522	523	9.7	NS
Day 42	528[a]	571[b]	553[ab]	532[a]	542	532	9.1	**
Day 84	542[a]	609[c]	600[c]	574[b]	591	573	8.8	***
Day 126	568[a]	645[b]	653[b]	653[b]	630	629	9.3	***

[1]No significant breed effect and no significant interactions
[2]For n = 22

Slaughter Data:

Slaughter data are shown in Table 5. All concentrate treatments significantly increased carcass weight, carcass gain, kill-out, all measures of fatness and improved conformation. There were few significant differences between the three concentrate treatments but there was a trend for all measures of fatness to decrease from FLAT to STEP to ADLB and the difference between FLAT and ADLB was significant for kidney plus channel fat as a proportion of carcass weight. In line with their higher intake and higher proportion of concentrates in the diet, carcass weight and gain were somewhat higher for ADLB than for the other two concentrate treatments. Compared with FR, CH had significantly greater carcass weight and carcass gain, a higher kill-out, better conformation and a higher fat score but a lower weight and proportion of kidney plus channel fat. Mean carcass gain responses were 49.2 kg for FLAT, 47.7 kg for STEP and 53.6 kg for ADLB. Mean carcass gains for CH and FR were 69.6 and 62.8 kg respectively.

Table 5. Effects of concentrate distribution pattern and breed on slaughter data of steers (Experiment 1).

	Feed				Breed (B)			siginficance	
	NONE	FLAT	STEP	ADLB	CH	FR	sed2	F	B
Carcass weight (kg)	286.4 a	335.6 b	334.2 b	340.0 b	333.1	316.4	5.30	***	**
Kill-out (g/kg)	504 a	521 b	512 ab	521 b	528	503	4.23	***	***
Conformation2	1.96 a	2.68 c	2.41 bc	2.77 c	2.95	2.04	0.123	***	***
Fat score3	2.85 a	3.76 b	3.67 b	3.51 b	3.63	3.30	0.100	***	**
Kidney + channel fat (kg)	9.7 a	15.6 b	14.1 b	14.0 b	12.4	14.5	0.80	***	*
Kidney + channel fat (g/kg)1	33.7 a	46.5 c	44.3 bc	41.1 b	36.8	45.2	2.14	***	***
Carcass gain (kg)2	28.3 a	77.5 b	76.0 b	81.9 b	69.6	62.8	3.12	***	**

[1]Forn = 22
[2]Scale 1(Poorest) to 5(Best)
[3]Scale 1(Leanrst) to 5(Fattest)
[4]Of carcass weight
[5]Based on initial carcass weight = initial liveweight x 0.485 (FR) or 0.505 (CH)
There were no significant interactions.

Assuming ME values of 10.0 MJ/kg DM for silage and 12.6 for concentrates (Keane et al., 1995), estimated total metabolisable energy (ME) intakes for NONE, FLAT, STEP and ADLB were 8620, 12467, 12872 and 13567 MJ, respectively. Corresponding efficiencies of energy utilisation (MJ ME/kg carcass gain) were 292, 161, 169 and 166.

EXPERIMENT 2

Because of the imbalanced design (no FR in NONE treatment), the means cannot be presented as main effects. Instead the individual treatment group means are presented.

Feed Intakes:

Feed intakes are shown in Table 6. When fed alone, silage DM intake increased slightly with time and averaged 8.17 kg/day (14.3 g/kg BW). Feeding 6 kg (5.25 kg DM) concentrates per day reduced silage intake from 56 days to slaughter by 3.49 kg/day. (The period 0 to 56 days is ignored because the full concentrate allowance was not consumed.) Overall, a total of 714 kg concentrate DM was fed to CH in FLAT for the entire finishing period. This reduce silage intake by 475 kg (substitution rate of 0.67 kg silage per kg concentrate DM) and increased total DM intake by 20%. In the period 98 to 147 days, when ADLB was receiving concentrates *ad libitum*, mean daily total DM intakes for CH on NONE, FLAT and ADLB were 8.7, 10.2 and 10.9 kg, respectively. When fed a fixed daily quantity of concentrates (FLAT), FR consumed 10% more silage and 5% more total DM than CH. On the ADLB treatment however, there was no difference in total DM intake but when concentrates were available *ad libitum* in the period 98 to 147 days, intake of FR was 10% higher than CH. This is at variance with Experiment 1 where CH had the highest concentrate intake when it was offered *ad libitum*. Mean total DM intakes were 1478 kg for FLAT and 1408 kg for ADLB corresponding to mean daily intakes of 10.05 (16.75 g/kg BW) and 9.58 (15.95 g/kg BW), respectively. Maximum CH intakes when concentrates were offered *ad libitum* after 98 days were 14.8 and 2.1 g/kg mean bodyweight for concentrates and silage, respectively. Corresponding values for FR were 16.0 and 2.1 g/kg. Mean total DM intakes for CH and FR were 9.7 kg (16.1 g/kg BW) and 10.0 kg (16.6 g/kg BW) per day, respectively.

Table 6. **Effects of concentrate distribution pattern and breed on feed intake (ks dry matter/day) of steers (Experiment 2).**

Feed (F)		NONE	FLAT		ADLB			Significance	
Breed (B)		CH	CH	FR	CH	FR	s.e.d.[1]	F	FxB
Days									
0-56	Silage	7.27	4.91	5.16	7.57	7.47	0.074	***	NS
	Conc.	---	4.22	4.22	---	---	---	***	---
56-98	Silage	8.51	5.20	5.80	5.68	5.34	0.049	***	*
	Conc.	---	5.25	5.25	5.09	4.57	0.066	***	NS
98-147	Silage	8.65	4.98	5.60	1.34	1.36	0.099	***	NS
	Conc.	---	5.25	5.25	9.56	10.55	0.066	***	NS
0-147	Silage	1201	726	801	721	703	9.68	***	**
	Conc.	---	714	714	682	709	11.9	***	NS

[1]For n = 4 [2]Total for experiment
There was no significant breed effect

Liveweights and Gains: Liveweight gains of the animals are shown in Table 7. Mean daily gain of the animals fed silage only was 655 g/day. This declined from 804 g/day in the first 56 days to 539 g/day in the period after 98 days. Mean daily gains for the FLAT and ADLB treatments were 1101 and 1132 g/day, respectively. Mean daily gains for CH and FR were 1078 and 1155 g/day, respectively (FLAT and ADLB combined). The overall mean response to 6 kg concentrates per head daily was 416 g/day liveweight gain for CH - a conversion rate of 14.4:1.

Liveweights of the animals are shown in Table 8. Mean initial liveweight was 523 kg for CH and 515 kg for FR. Final liveweights were almost identical for all concentrate supplemented groups. The overall response to concentrates fed FLAT was 61 kg liveweight for an input of 714 kg concentrate DM and a reduction of 475 kg silage DM. Thus, each 1 kg extra liveweight required 11.7 kg concentrate DM and "saved" 7.8 kg silage DM. The similarity in final weights between CH and FR was surprising considering that CH had a weight advantage initially and are known to have a higher growth rate generally. For reasons which are not obvious the FLAT CH group performed particularly poorly in the period from 98 days to slaughter (617 g/day v 539 g/day for NONE). By contrast the ADLB FR group performed particularly well in the first 56 days (1043 g/day) when they received no concentrates. While gut fill changes may have been a confounding factor in the ADLB group because of their changing diet over time, there should be consistency between the two breed types as diet changes occured simultaneously.

Table 7. Effects of concentrate distribution pattern and breed on liveweight gains of steers (Experiment 2).

Feed (F)	NONE	FLAT		ADLB			Significance	
Breed (B)	CH	CH	FR	CH	FR	s.e.d.[1]	F	FxB
No. of animals	12	12	12	12	12			
Daily Gains (g)								
0-56 days	804	1512	1348	839	1043	51.7	***	*
56-98 days	591	1012	1040	901	1409	132.7	**	NS
98-147days	539	617	962	1522	1136	116.5	***	*
0-147 days	655	1071	1131	1084	1179	37.3	***	NS

[1]For n = 24

Table 8. Effects of concentrate distribution pattern and breed on liveweights of steers (Experiment 2).

Feed(F)	NONE	FLAT		ADLB		Significance	
Breed(B)	CH	CH	FR	CH	FR	s.e.d.[1]	F
Liveweights at (kg)							
Initial	523	523	515	523	515	7.9	N.S
Day 56	568	607	591	570	573	8.0	*
Day 98	592	650	635	608	633	9.2	*
Day 147	619	680	682	682	688	9.3	**

[1]For n = 24 There was no significant breed effect and no significant interactions

Slaughter Data: Slaughter data are shown in Table 9. Feeding concentrates increased carcass weight and gain, increased kill-out, improved conformation and increased all measures of fatness. There were no significant differences between FLAT and ADLB in carcass weight or gain, kill-out or conformation, but fat score, weight of kidney plus channel fat and of kidney plus channel fat as a proportion of carcass weight were significantly lower for ADLB than FLAT. Although they had similar carcass gains, FR had lower carcass weights than CH. There was no significant breed effect on fat score or kidney plus channel fat weight but FR had a higher proportion of kidney plus channel fat. Mean carcass gain responses for FLAT and ADLB were 42.7 and 47.0 kg, respectively. Mean carcass gains for CH and FR were 100.9 and 102.4 kg, respectively.

On the same basis as for Experiment 1, estimated total ME intakes were respectively 12010 (NONE CH), 16256 (FLAT CH), 17006 (FLAT FR), 15803 (ADLB CH) and 15963 (ADLB FR) MJ for the total experiment. Corresponding efficiencies of energy utilisation (MJ ME/kg carcass gain) were 215, 165, 172, 153 and 151. These values for the concentrate supplemented groups are similar to those for Experiment 1.

Table 9. Effects of concentrate distribution pattern and breed on slaughter data of steers (Experiment 2).

Feed (F)	NONE	FLAT		ADLB			Significance	
Breed (B)	CH	CH	FR	CH	FR	s.e.d.[1]	F	FxB
Carcass weight (kg)	319.8	362.6	348.9	367.0	355.4	5.39	***	NS
Kill-out (g/kg)	519	533	513	537	517	3.25	*	***
Conformation[2]	2.33	3.08	1.83	3.08	2.08	0.073	***	***
Fat score[3]	3.38	4.00	4.32	3.66	3.80	0.088	***	NS
Kidney + channel fat (kg)	12.3	18.6	19.6	14.6	17.6	0.631	***	NS
Kidney + channel fat (g/kg)[4]	38.6	51.2	56.2	39.4	49.7	1.67	***	**
Carcass gain (kg)[5]	56.0	98.7	99.0	103.0	105.7	3.31	***	NS

[1]For n = 24; [2]Scale 1 (poorest) to 5 (best); [3]Scale 1 (leannest) to 5 (fattest);
[4]Of carcass weight; [5]Based on initial carcass weight = initial liveweight x 0.485 (FR) or 0.505 (CH)
There were no significant interactions

COMPARISONS ACROSS EXPERIMENTS

Since FLAT and ADLB are the treatments of most practical interest and since they were balanced for breed type and number of animals, these two treatments were compared directly using all the data. (Since weighing dates and measurement periods did not coincide exactly for the two experiments, the periods indicated are approximate and the values are not necessarily the period means for Experiments 1 and 2.)

Feed intakes are shown in Table 10. Neither silage nor concentrate intakes differed significantly between the treatments. Mean values (DM) were 705 kg silage and 616 kg concentrates for FLAT and 639 kg silage and 687 kg concentrates for ADLB giving total DM intakes of 1321 and 1326 kg, respectively with corresponding concentrate proportions in the DM of 46.6% and 48.2%. CH consumed 643 kg silage and 661 kg concentrates and FR consumed 700 kg silage and 642 kg concentrates. The higher (9%) silage consumption of FR was significant. Overall DM intakes were 1304 kg for CH and 1342 kg for FR (+3%). Thus, FR consumed more silage but not more concentrate when it was available *ad libitum*.

Table 10. Comparison of flat and variable concentrate distribution patterns for feed intake (kg Dry Matter per day) of steers.

Feed(F)			FLAT		ADLB			Significance	
Breed(B)			CH	FR	CH	FR	s.e.d.[1]	F	B
(Period)		(Days[2])							
Early	Silage	0-53	4.59	5.22	7.47	7.72	0.202	***	NS
	Conc.	0-53	3.29	3.62	---	---	0.151	***	NS
Middle	Silage	53-98	4.94	5.53	5.81	5.91	0.276	**	NS
	Conc.	53-98	4.82	4.82	3.39	2.70	0.203	***	NS
Late	Silage	98-137	4.73	5.67	1.32	1.34	0.072	***	NS
	Conc.	98-137	4.82	4.82	10.71	10.36	0.242	***	NS
Total	Silage	0-137	655	754	631	646	20.9	NS	*
	Conc.	0-137	609	622	712	662	27.7	NS	NS

[1] For n = 8

[2] Approximately - different periods for each of the experiments

[3] Total for experiment

There were no significant interactions.

Liveweight gains are shown in Table 11. Daily gains were consistent for feeding treatments and breed types. For the FLAT treatment, mean daily gains were 1218, 909 and 941 g for the early, mid and late parts of the finishing period, respectively, resulting in a mean overall value of 1041 g. The corresponding values for ADLB were 638, 972 and 1832 g, and 1089 g overall. Mean daily gains were 1073 1056 g for CH and FR

Table 11. Comparison of flat and variable concentrate distribution patterns for liveweight gains of steers.

Feed(F)		FLAT		ADLB		Significance	
Breed(B)	Period (days)	CH	FR	CH	FR	s.e.d.[2]	F
No. of animals		22	24	22	24		
Daily gains (g)							
Start to early	53	1313	1122	676	599	58.1	***
Early to late	45	915	902	987	956	86.4	NS
Late to slaughter	39	805	1077	1815	1849	46.7	***
Start to slaughter	137	1041	1039	1104	1073	37.8	NS

[1]For n = 46

There was no significant effect of breed and no interactions

Liveweights are shown in Table 12. Liveweights of all groups were similar at the start and at the end.

Slaughter data are shown in Table 13. There was no significant effect of feeding treatment on carcass weight or gain, kill-out or conformation. However, ADLB significantly reduced fat score, kidney plus channel fat weight and kidney plus channel fat as a proportion of carcass weight. Carcass weight was heavier for CH than FR but there was no difference in carcass gain. Conformation was better for CH than FR but there was no difference in fat score. Kidney plus channel fat weight and its proportion of carcass weight were lower for CH than FR. Estimated mean ME intakes were 14223 (FLAT CH), 15377 (FLAT FR), 15281 (ADLB CH) and 14801 (ADLB FR) MJ. Corresponding efficiencies of energy utilisation for carcass gain (MJ/kg) were 158, 176, 157 and 164. This gives mean values of 158 and 170 for CH and FR, respectively.

Table 12. **Comparison of flat and variable concentrate distribution patterns for liveweights of steers.**

Feed(F)	FLAT		ADLB		Significance	
Breed(B)	CH	FR	CH	FR	s.e.d.[2]	F
Liveweights at (kg)						
Initial	522	519	522	519	6.01	NS
Early (53 days)	592	579	558	551	6.37	***
Late (98 days)	634	620	603	594	7.21	**
Slaughter (137 days)	665	662	674	666	7.07	NS

[1]For n = 46
There was no significant effect of breed and no interactions

Table 13. **Comparison of flat and variable concentrate distribution patterns for slaughter data of steers.**

Feed(F)	FLAT		ADLB			Significance	
Breed(B)	CH	FR	CH	FR	s.e.d.[1]	F	B
Carcass weight (kg)	353.6	339.2	361.1	341.9	4.62	NS	***
Kill-out (g/kg)	532	513	536	513	2.52	NS	***
Conformation	3.09	2.08	3.23	2.17	0.087	NS	***
Fat score	4.00	3.94	3.68	3.58	0.084	***	NS
Kidney + channel fat (kg)	16.6	18.2	13.7	16.4	0.636	***	*
Kidney + channel fat (g/kg)	46.8	53.4	37.7	47.7	1.66	***	***
Carcass gain (g)	89.9	87.4	97.3	90.2	3.16	NS	NS

[1]For n = 46
See Table 9 footnotes also
There were no significant interactions

DISCUSSION

FEED INTAKES

The mean intakes of silage alone were 6.8 and 8.2 kg/day in Experiments 1 and 2, respectively giving corresponding intakes per kg mean liveweight of 12.6 and 14.3 g/kg. Since the animals offered silage only from Experiment 1 were 50:50 CH and FR, whereas they were all CH in Experiment 2, a higher intake would be expected in Experiment 1 since FR generally had a higher silage intake than CH. The only obvious explanation for the differences in intake between the two experiments was silage quality. In Experiment 2, silage digestibility was somewhat higher but the main difference was in pH which was lower in Experiment 1 (3.70 v 3.93). There is evidence that low pH silage tends to have low intake characteristics.

Based on the data for the FLAT treatment, the substitution rate of concentrates for silage on a DM basis was 0.49 in Experiment 1 and 0.67 in Experiment 2. Consequently, each 1 kg concentrate DM increased total DM intake by 0.51 kg in Experiment 1 and 0.33 kg in Experiment 2. Mean daily DM intakes for the FLAT treatment were 8.9 kg in Experiment 1 and 9.8 kg in Experiment 2, representing 15.2 g/kg bodyweight in Experiment 1 and 16.3 g/kg in Experiment 2. While most of this difference can be explained by the fact that the animals in Experiment 2 got 1 kg/day extra concentrates (6 v 5 kg/day), overall intakes were nevertheless quite low and lower than generally reported.

When fed concentrates *ad libitum* total intake was 19.6 g/kg mean liveweight of which 17.4 g/kg was concentrate in Experiment 1. The corresponding values for Experiment 2 were 17.5 and 15.4. Part of the reason for this difference was that the animals were heavier in Experiment 2 but mean concentrate intake was actually higher in Experiment 1 (10.7 v 10.1 kg).

In both experiments, FR consumed more silage than CH. At the same concentrate input they had 10% higher silage intake. Across both experiments, total DM intake was 3% greater for FR than CH.

LIVEWEIGHTS AND GAINS

While the higher intake and better quality silage would partly explain the higher performance of the animals fed silage only in Experiment 2, it would not account for all of the difference.

Gut fill effects are probably the explanation for the remainder. For the animals fed concentrates, there was good agreement between the two experiments in overall liveweight gains. Mean daily gains for the FLAT and ADLB treatments were respectively 968 and 1035 g/day in Experiment 1 and 1101 and 1132 g/day in Experiment 2. The higher values in Experiment 2 could be explained by the higher concentrate level and better quality silage. Where concentrates were fed FLAT, performance generally declined with increasing length of finishing period. With ADLB, liveweight gain reached 1.8 kg/day in the final part of the finishing period.

SLAUGHTER DATA

Feeding concentrates improved kill-out and conformation and increased all measures of fatness. Otherwise, the main finding of interest was the lower fatness of the ADLB compared with the FLAT animals. Since these animals were growing faster towards the end of the finishing period when most fat is being deposited the opposite might have been expected. However, it should also be kept in mind that they consumed very little silage in the final period and many experiments have shown that fatness decreases as the diet contains less silage.

CH had heavier carcasses, a higher kill-out and better conformation than FR. These differences would be expected from previous results. The breeds did not differ in fat score but CH had less kidney plus channel fat weight and proportion than FR. This may just be a reflection of FR having a greater proportion of internal fat at the same carcass fatness or it may reflect disagreement between fat score and kidney plus channel fat weight or proportion as indicators of fatness.While concentrate distribution pattern had no influence on overall performance or efficiency during finishing, there may be management and carcass quality advantages to the ADLB approach. Management should be simplified by feeding silage only in the first half of the finishing period and then feeding all the concentrates over the second half. This should also make it easier to judge how much concentrates would be required to achieve a certain carcass weight or finish. Fatness was reduced by the ADLB strategy which should result in higher meat yields. Meat quality and colour should be improved because of the high rate of gain pre-slaughter and the high proportion of concentrates in the diet.

SUMMARY/CONCLUSIONS

- Two experiments used 148 steers (76 Charolais x Friesians (CH) and 72 Friesians (FR)) to study the effects of the distribution pattern of supplementary concentrates with silage during finishing. Three distribution patterns were compared and a control group received silage only (NONE). The distribution patterns were: 1) a constant allowance daily throughout (FLAT), 2) a stepped pattern - low initially increasing thereafter (STEP), and 3) all the concentrates fed *ad libitum* over the second half of the finishing period (ADLB). It was intended that all supplemented groups receive the same total concentrate allowance. All animals were slaughtered at the end of the study.

- The STEP treatment was used only in Experiment 1 and the results were similar to those for FLAT.

- Mean intakes of the animals fed silage only were 6.8 and 8.2 kg/day equivalent to 12.6 and 14.3 g/kg mean bodyweight for Experiments 1 and 2, respectively. The low intake in Experiment 1 may have been due to low silage pH.

- The substitution rate of concentrates for silage on a DM basis was 0.49 and 0.67 in Experiments 1 and 2, respectively.

- Mean daily total DM intakes (for FLAT) were 8.9 and 9.8 kg DM in Experiments 1 and 2, respectively or 15.2 and 16.3 g/kg mean bodyweight. When fed concentrates *ad libitum*, total DM intakes were 10.7 kg and 10.1 kg concentrates plus 1.33 and 1.35 kg silage in Experiments 1 and 2, respectively. These correspond to values of 19.6 and 17.5 g/kg body weight for total DM intake.

- At the same concentrate input, FR had 10% higher silage DM intake than CH.

- Concentrate distribution pattern had no significant effect on overall daily gain during finishing and there was no interaction with breed type

- Mean daily gains (two experiments combined for the 1st, 2nd and 3rd one-third fractions of the finishing period were 1218, 909 and 941 g/day for FLAT. The corresponding vaues ADLB were 648, 972 and 1832 g/day.

- In Experiment1 and using FLAT as the basis, each kg supplementary concentrate DM reduced silage intake by 0.45 kg DM, increased liveweight gain by 153 g/day and increased carcass gain by 99 g/day. The corresponding values of Experiment 2 were 0.67 kg, 86 g/day and 60 g/day.

- Concentrate distribution pattern had no effect on carcass gain, carcass weight, kill-out or carcass conformation score.

- Concentrate distribution pattern significantly affected carcass fatness with the ADLB treatment reducing all measures of fatness.

- Mean efficiencies of conversion of ME to carcass weight (MJ ME/kg carcass gain) for NONE, FLAT, STEP and ADLB were 292, 161, 169 and 166 for Experiment 1 and 215, 165, 172 and 153 for Experiment 2.

- There should be management advantages to the ADLB approach in that it separates silage and concentrate feeding during the fattening period. In addition, because of the high pre-slaughter rate of gain and the low proportion of silage in the diet pre-slaughter, muscle tenderness and colour should be improved.

ACKNOWLEDGEMENTS

The author acknowledges the skilled technical assistance of Mr. T. Darby and Mr. F. Collier.

REFERENCES

Keane, M.G. (1998). Concentrates for Beef Production. Nutribio Conference "Quality Assured Animal Feed", October, 1998.

Keane, M.G., Read, M.P. and Moloney, A.P. (1995). Effects of Ardacin supplementation on feed intake and growth rate of growing and finishing steers. Animal Science, 60: 409-417.

PUBLICATIONS

Keane, M.G. (1996). Role of concentrates in beef production. In: Elanco Animal Health Beef Seminar, 27 September, 1996, 14 pages.

Keane, M.G. (1997). Low cost quality beef production. In: Pfizer Beef Symposium, Dublin, 23 June, 1997, 17 pages.

Keane, M.G. (1997). Winter Beef : High performance key to tight margins. Irish Farmers Journal, November 22, pages 16-17.

Keane, M.G. (1997). Options for concentrate feeding of beef cattle. In: Irish Grain and Feed Association Feed Forum, Dublin, 1 November, 1997, 18 pages.

Keane, M.G. (1997). Winter finishing of beef cattle. Todays Farm, 8: 4: 23-24.

Keane, M.G. (1998). Concentrates for Beef Production. In: Quality Assured Animal Feed, Nutribio Conference, Portlaoise, 5 October, 1998, 19 pages.

Appendix 1. Concentrate distribution pattern and feed intake - interactions (Experiment 1).

Feed(F)		NONE		FLAT		STEP		ADLB			Significance		
Breed(B)		CH	FR	CH	FR	CH	FR	CH	FR	s.e.d.[1]	F	B	FxB
Period(days)													
0-42	Silage	7.22	8.02	4.27	5.28	5.70	5.96	7.35	7.99	0.348	***	***	NS
	Conc.	---	---	2.63	3.29	1.65	1.65	---	---	0.001	***	***	NS
42-84	Silage	6.36	6.88	4.69	5.26	4.84	5.33	4.76	5.28	0.051	***	***	***
	Conc.	---	---	4.38	4.38	4.17	4.13	4.11	2.75	0.035	***	***	***
84-126	Silage	5.97	7.51	4.49	5.73	3.69	4.86	1.30	1.32	0.041	***	***	***
	Conc.	---	----	4.38	438	6.39	6.41	11.31	9.96	0.284	***	***	NS
0-126	Silage	802	923	560	676	580	665	522	565	28.9	***	***	NS
	Conc.	---	---	529	528	487	511	643	588	13.9	***	NS	**

[1]For n = 4

Appendix 2. Concentrate distribution pattern and performance - interactions (Experiment 1).

Feed(F)	NONE		FLAT		STEP		ADLB			Significance		
Breed(B)	CH	FR	CH	FR	CH	FR	CH	FR	s.e.d.[1]	F	B	FxB
No. animals	10	12	10	12	10	12	10	12				
Daily gains (g)												
0-42 days	224	48	1255	1055	876	581	548	133	88.6	***	**	NS
42-84 days	412	281	936	893	1048	1176	1238	631	59.2	***	***	**
84-126 days	379	824	774	907	1057	1440	1562	2138	54.5	***	***	NS
0-126 days	338	384	988	952	994	1066	1116	631	57.8	***	NS	NS

[1]For n = 4

Appendix 3. **Concentrate distribution pattern and liveweights - interactions (Experiment 1).**

Feed(F)	NONE		FLAT		STEP		ADLB		Significance	
Breed(B)	CH	FR	CH	FR	CH	FR	CH	FR	s.e.d. [1]	F
Liveweight (kg) at										
Initial	522	523	522	523	522	523	522	523	13.1	NS
Day 42	5315	525	575	567	559	547	545	529	12.3	**
Day 84	549	537	614	605	603	597	597	555	11.9	***
Day 126	564	571	646	643	647	657	663	645	12.5	***

[1]For n = 12. There were no significant breed effects or interactions

Appendix 4. Concentrate distribution pattern and slaughter data-inter actions (Experiment 1).

Feed(F)	NONE		FLAT		STEP		ADLB		Significance		
Breed(B)	CH	FR	CH	FR	CH	FR	CH	FR	s.e.d[1]	F	B
Carcass weight (kg)	292.6	281.2	342.9	329.4	343.0	326.8	354.0	328.3	7.18	***	**
Kill-out (g/kg)	518	492	530	513	530	497	534	509	5.73	***	***
Conformation	2.40	1.58	3.10	2.33	2.90	2.00	3.40	2.25	0.167	***	***
Fat score	2.93	2.78	3.99	3.57	3.88	3.50	3.70	3.35	0.135	***	**
Kidney + channel fat (kg)	8.7	10.5	14.3	16.7	14.0	15.5	12.6	15.1	1.08	***	*
Kidney + channel fat (g/kg)	29.6	37.1	41.5	50.6	40.5	47.5	35.6	45.6	2.90	***	***
Carcass gain (kg)	29.1	27.6	79.4	75.8	79.4	73.2	90.5	74.7	4.22	***	**

[1]For n = 12. There were no significant breed effects or interactions.