Final Report to SFF

Grant No. 06/067

Pasture and forage options for store lamb and beef production from South Island hill and high country.

Appendix 3 – Nutritive Yields

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August 2009

Appendices – Nutritive Value and Yields

- Nutritive quality determined by NIRS at Lincoln University.
- Protein values calculated as N%*6.25 (Waghorn 2007) and therefore protein values have not been statistically analysed because they represent a constant multiplication.
- Yield determined by destructive harvest and botanical composition.
- Nutritive value of sown species is multiplied by sown species yield to determine metabolisable energy (ME; GJ ME/ha, kg N/ha and kg crude protein/ha. Annual ME, N and crude protein is calculated from annual yield from sown species multiplied by nutritive value.
- Stock units (SU) determined by assuming one SU equates to a 55 kg ewe with a single lamb (Flemming 2003) with a requirement of 27 MJ ME/day for suckling lambs 1-2 weeks after lambing (Geenty and Rattray 1987). Lambing at Mt Pember Station occurs mid October.

Perennial grasses

Background

- On 13th of February 2006 grasses were sown ('Aries HD' ryegrass at 5, 10 and 15 kg/ha, 'Cannon LE' ryegrass 'Gala' grazing brome, 'Kara' cocksfoot, 'Viking' timothy and 'Advance' tall fescue) in eight treatments and four replicates.
- On 1st of November 2006 'Revolution' ryegrass and 'Bareno' brome were sown.
- In January, June, November 2007 and October 2008 plots were grazed in common. They were mechanically topped in September 2008, and then grazed in January and April 2009.
- In spring 2007, N (150 kg N/ha) was applied to one half of each of the grass plots on the 15/8/07.
- In autumn 2008, N (46 kg N/ha) was applied on 19/2/08.
- Visual symptoms of N deficiency were still obvious in grass plots that did not receive N in spring 2007 and therefore an additional 46 kg N/ha was applied to these plots on 16/3/08.
- In spring 2008, N (50 kg N/ha) was applied on 10/8/08.
- In September 2008, maintenance fertiliser (300 kg/ha superphosphate) and urea at 50 kg N/ha were applied to all grass plots.

Annual nutritive yield: Year 2

- Grass plots split in half. Half of the plots received 150 kg N/ha (+N) in the form of calcium ammonium nitrate on 15 August 2007. The remaining half received no nitrogen (-N).

Appendix 1. Annual ME, N and protein yields from the sown grass component for Year 2 (+N): 1/7/07-8/4/08 (282 days). Harvested on: 20/11/07 and 8/4/08.

Species	Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Ryegrass	'Aries HD' 5 kg/ha	36.0 $_{b}$	78.9 $_{ab}$	493
	'Aries HD' 10 kg/ha	43.0 $_{b}$	86.0 $_{ab}$	537
	'Aries HD' 15 kg/ha	41.8 $_{b}$	94.1 $_{ab}$	588
	'Cannon LE'	41.0 $_{b}$	81.4 $_{ab}$	509
	'Revolution'	67.5 $_{a}$	113.0 $_{ab}$	706
Brome	'Bareno'	38.9 $_{b}$	89.6 $_{ab}$	560
	'Gala'	12.0 $_{c}$	31.6 $_{c}$	197
Cocksfoot	'Kara'	36.0 $_{b}$	81.6 $_{ab}$	510
Tall fescue	'Advance'	28.5 $_{b}$	65.7 $_{bc}$	411
Timothy	'Viking'	39.1 $_{b}$	88.6 $_{ab}$	554
	Mean	38.4	81.0	507
	SEM	5.08	13.5	
	P value	<0.001	0.033	

Treatment means followed by the same letter subscript are not significantly different.

Main results:

- Annual ME was highest from the 'Revolution' (67.5 GJ/ha) due to higher annual sown grass yield (5.6 t DM/ha, Appendix 1 Botanical composition).
- Nitrogen yield ranged from 31.6 kg/ha for 'Gala' to 113 kg/ha for 'Revolution'.

Note: for a comparison of plots without nitrogen (-N) see Appendix 8.

Annual nutritive yield: Year 3

- Spring N (50 kg N/ha as urea) applied to all treatments 12/9/08.

Appendix 2. Annual ME, N and protein yields from the sown grass component for Year 3: 2/7/08-21/4/09 (293 days). Harvested on: 10/9/08, 21/10/08, 14/1/09 and 21/4/09.

Species	Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Ryegrass	'Aries HD' 5 kg/ha	15.0	29.3	183
	'Aries HD' 10 kg/ha	11.7	21.3	133
	'Aries HD' 15 kg/ha	12.0	22.9	143
	'Cannon LE'	13.1	23.6	147
	'Revolution'	17.4	30.9	193
Brome	'Bareno'	15.1	41.2	257
	'Gala'	5.9	16.7	104
Cocksfoot	'Kara'	13.0	31.2	194
Tall fescue	'Advance'	13.2	32.0	200
Timothy	'Viking'	11.4	24.9	155
	Mean	12.5	26.6	166
	SEM	2.13	4.84	
	P value	0.061	0.081	

Main results:

- ME mean yield was 12.5 GJ/ha.
- N yield ranged from 16.7 ('Gala') to 32.0 kg/ha (tall fescue).
- Both ME and N yields were lower in Year 3 than Year 2 (Appendix 1), due to lower sown grass yields (Appendices 1 and 3; Botanical composition).

Individual Harvests: Year 2

- Grass plots split in half. Half of the plots received 150 kg N/ha (+N) in the form of calcium ammonium nitrate on 15/8/07. The remaining half received no nitrogen (-N).
- Harvests for +N on 1/10 and 12/10, 5/11 (mid rotation harvests) and 20/11/07 (end of rotation), final harvest on 8/4/08.
- Harvests for –N on 25 October (mid rotation) and 20 November 2007 (end of rotation).

Appendix 3. Harvested on 1 October 2007 (+ N) regrowth period: 15/8-1/10/2007 (47 days).

Species	Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Ryegrass	'Aries HD' 5 kg/ha	6.4 $_{d}$	24.3 $_{c}$	151
	'Aries HD' 10 kg/ha	6.5 $_{d}$	29.8 $_{c}$	186
	'Aries HD' 15 kg/ha	8.0 $_{cd}$	31.6 $_{c}$	197
	'Cannon LE'	7.6 $_{d}$	31.2 $_{c}$	194
	'Revolution'	18.0 $_{a}$	82.2 $_{a}$	513
Brome	'Bareno'	12.4 $_{bc}$	54.7 $_{b}$	342
	'Gala'	6.7 $_{d}$	28.4 $_{c}$	177
Cocksfoot	'Kara'	13.1 $_{b}$	61.1 $_{ab}$	382
Tall fescue	'Advance'	7.5 $_{d}$	31.1 $_{c}$	194
Timothy	'Viking'	15.0 $_{ab}$	67.1 $_{ab}$	419
	Mean	10.1	44.2	276
	SEM	1.40	6.74	
	P value	0.002	0.001	

Treatment means followed by the same letter subscript are not significantly different.

Main results late winter – early spring:

- ME yield from 'Revolution' (18 GJ/ha) was higher than from other pasture grasses except timothy.
- 'Revolution' had the highest N yield (82 kg/ha) of all species.
- Ryegrass ME and N yield were unaffected by initial sowing rate.

Appendix 4. Harvested on 25 October 2007 (+ N) regrowth period: 15/8-25/10/07 (71 days).

Species	Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Ryegrass	'Aries HD' 5 kg/ha	18.5 $_{bcd}$	50.0	312
	'Aries HD' 10 kg/ha	16.4 $_{bcd}$	53.5	334
	'Aries HD' 15 kg/ha	18.2 $_{bcd}$	47.2	294
	'Cannon LE'	21.1 $_{b}$	59.2	369
	'Revolution'	21.1 $_{b}$	49.1	306
Brome	'Bareno'	13.9 $_{d}$	43.0	268
	'Gala'	15.1 $_{cd}$	50.4	315
Cocksfoot	'Kara'	15.0 $_{d}$	49.5	309
Tall fescue	'Advance'	19.8 $_{bc}$	55.6	347
Timothy	'Viking'	26.4 $_{a}$	73.1	456
	Mean	18.6	53.0	331
	SEM	1.57	6.31	
	P value	<0.001	0.15	

Treatment means followed by the same letter subscript are not significantly different.

Main results late winter – mid spring (+N):

- ME yield was lower from 'Bareno' and cocksfoot than the ryegrasses and timothy.
- The mean N yield was 53.0 kg/ha.
- The mean ME (18.6 GJ/ha) would carry 9.7 SU/ha for 71 days, but this would range from 7.2 SU/ha for 'Bareno' to 13.8 SU/ha for timothy.

Appendix 5. Harvested on 25 October 2007 (– N) regrowth period: 15/8-25/10/07 (71 days).

Species	Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Ryegrass	'Aries HD' 5 kg/ha	3.3 $_{bcd}$	6.1	38.1
	'Aries HD' 10 kg/ha	2.5 $_{cd}$	5.7	35.3
	'Aries HD' 15 kg/ha	3.5 $_{bcd}$	6.9	42.9
	'Cannon LE'	3.7 $_{bcd}$	7.4	46.2
	'Revolution'	9.5 $_{a}$	16	100
Brome	'Bareno'	7.4 $_{ab}$	18	114
	'Gala'	1.8 $_{d}$	4.4	27.3
Cocksfoot	'Kara'	3.6 $_{bcd}$	9.5	59.4
Tall fescue	'Advance'	4.1 $_{bcd}$	8.6	53.9
Timothy	'Viking'	6.4 $_{abc}$	10.5	65.9
	Mean	4.6	9.4	58.8
	SEM	1.46	3.22	
	P value	<0.001	0.151	

Treatment means followed by the same letter subscript are not significantly different.

Main results late winter – mid spring (-N):

- 'Revolution' had the highest ME yield (9.5 GJ/ha). Other perennial ryegrasses averaged 3.3 GJ/ha.
- Nitrogen yield ranged from 4.4 ('Gala') to 18 ('Bareno') kg/ha.
- These yields were less than 25% of those from the +N plots. The 44 kg N/ha difference in N recovered was due to the 150 kg of N applied.

Appendix 6. Harvested on 5 November 2007 (+N) regrowth period: 15/8-5/11/07 (82 days).

Species	Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Ryegrass	'Aries HD' 5 kg/ha	25.4 $_{b}$	61.7	385
	'Aries HD' 10 kg/ha	27.4 $_{b}$	70.7	442
	'Aries HD' 15 kg/ha	29.0 $_{b}$	74.2	463
	'Cannon LE'	26.2 $_{b}$	63.5	396
	'Revolution'	36.2 $_{a}$	78.2	488
Brome	'Bareno'	25.5 $_{b}$	71.7	448
	'Gala'	14.4 $_{c}$	47.3	295
Cocksfoot	'Kara'	26.0 $_{b}$	73.6	460
Tall fescue	'Advance'	21.8 $_{bc}$	68.4	427
Timothy	'Viking'	27.3 $_{b}$	61.2	382
	Mean	25.9	67.1	419
	SEM	3.30	9.66	
	P value	0.02	0.57	

Treatment means followed by the same letter subscript are not significantly different.

Main results late winter – late spring (+N):

- The mean ME yield was 25.9 GJ/ha and ranged from 14.4 for 'Gala' to 36.2 GJ/ha from 'Revolution'.
- Nitrogen yield averaged 67.1 kg/ha.
- There were no differences in total ME or N yields from the 5 – 15 kg/ha sowing rates of 'Aries HD'.

Note: Appendices 7 and 8 are the end of rotation harvests for +N (150 kg N/ha) and –N (0 kg N/ha) treatments in spring 2007.

Appendix 7. Harvested on 20 November 2007 (+N) regrowth period: 15/8-20/11/07 (97 days).

Species	Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Ryegrass	'Aries HD' 5 kg/ha	31.0 $_{bc}$	69.9 $_{ab}$	436
	'Aries HD' 10 kg/ha	34.0 $_{bc}$	73.7 $_{ab}$	460
	'Aries HD' 15 kg/ha	37.3 $_{b}$	87.8 $_{a}$	549
	'Cannon LE'	35.3 $_{b}$	73.1 $_{ab}$	456
	'Revolution'	55.0 $_{a}$	93.4 $_{a}$	583
Brome	'Bareno'	34.8 $_{bc}$	81.3 $_{ab}$	508
	'Gala'	8.70 $_{d}$	23.9 $_{c}$	149
Cocksfoot	'Kara'	31.4 $_{bc}$	74.1 $_{ab}$	463
Tall fescue	'Advance'	21.2 $_{c}$	50.1 $_{bc}$	312
Timothy	'Viking'	32.4 $_{bc}$	77.1 $_{ab}$	481
	Mean	32.1	70.4	440
	SEM	4.75	12.3	
	P value	<0.001	0.025	

Treatment means followed by the same letter subscript are not significantly different.

Main results late winter – end of spring (+N):

- The ME yield of 8.70 GJ/ha for 'Gala' was lower than all other grasses. The highest yield (55.0 GJ/ha) was from 'Revolution'.
- Nitrogen yield was higher in the ryegrasses (with no differences among sowing rates) than 'Gala'.
- The mean ME yield of tall fescue would accommodate 8.1 SU/ha over 97 days compared with 21 SU/ha for 'Revolution'.

Appendix 8. Harvested on 20 November 2007 (–N) regrowth period: 15/8-20/11/07 (97 days).

Species	Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Ryegrass	'Aries HD' 5 kg/ha	10.8	13.5	84.3
	'Aries HD' 10 kg/ha	9.0	12.2	76.4
	'Aries HD' 15 kg/ha	14.3	18.6	116
	'Cannon LE'	11.8	18.7	117
	'Revolution'	6.3	11.3	70.9
Bromes	'Bareno'	9.3	13.3	82.9
	'Gala'	13.6	16.1	101
Cocksfoot	'Kara'	12.9	14.5	90.8
Tall fescue	'Advance'	10.6	19.0	119
Timothy	'Viking'	12.2	11.8	73.7
	Mean	11.1	14.9	93.0
	SEM	2.16	2.96	
	P value	0.31	0.45	

Main results late winter – end of spring (-N):

- The mean ME yield was 11.1 (GJ/ha) and N yield was 14.9 kg/ha.
- The mean ME and N yields for grass with no N were at least 50% less than when 150 kg N/ha was applied.
- The mean ME (11.1 GJ/ha) would carry 4.2 SU/ha for 97 days, which was 3 times less than grasses receiving 150 kg N/ha (Appendix 8).

Appendix 9. Harvested on 8 April 2008 (+N) regrowth period: 17/1-8/4/08 (82 days).

Species	Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Perennial ryegrasses	'Aries HD' 5 kg/ha	5.0 $_{bcd}$	9.1	56.7
	'Aries HD' 10 kg/ha	8.9 $_{ab}$	12.2	76.5
	'Aries HD' 15 kg/ha	4.5 $_{cd}$	6.3	39.4
	'Cannon LE'	5.6 $_{bcd}$	8.3	51.9
	'Revolution'	12.5 $_{a}$	19.5	121
Brome	'Bareno'	4.1 $_{cd}$	8.3	51.6
	'Gala'	3.3 $_{d}$	7.7	48.1
Cocksfoot	'Kara'	4.6 $_{cd}$	7.5	46.9
Tall fescue	'Advance'	7.3 $_{bc}$	15.6	97.8
Timothy	'Viking'	6.7 $_{bcd}$	11.5	72.0
	Mean	6.3	10.6	66.2
	SEM	1.35	3.02	
	P value	0.002	0.09	

Treatment means followed by the same letter subscript are not significantly different.

Main results mid summer – mid autumn (+N):

- 'Revolution' had the highest ME yield of 12.5 GJ/ha and 'Gala' was the lowest.
- Nitrogen yield was 10.6 kg/ha, which reflects the low soil nitrogen mineralisation in these soils.

Individual Harvests: Year 3

Appendix 10. Harvest on 10 September 2008. Regrowth period 11/4-10/9/08 (152 days).

Species	Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Ryegrass	'Aries HD' 5 kg/ha	6.2 $_{bc}$	13.9 $_{bc}$	87.2
	'Aries HD' 10 kg/ha	6.0 $_{bc}$	10.6 $_{bc}$	66.3
	'Aries HD' 15 kg/ha	5.3 $_{c}$	10.8 $_{bc}$	67.3
	'Cannon LE'	6.2 $_{bc}$	12.3 $_{bc}$	76.9
	'Revolution'	9.5 $_{a}$	18.4 $_{b}$	114.0
Brome	'Bareno'	8.5 $_{ab}$	23.3 $_{a}$	146.0
	'Gala'	3.7 $_{c}$	10.6 $_{bc}$	66.4
Cocksfoot	'Kara'	4.0 $_{c}$	11.4 $_{bc}$	71.2
Tall fescue	'Advance'	5.6 $_{bc}$	13.1 $_{bc}$	81.8
Timothy	'Viking'	3.7 $_{c}$	9.5 $_{c}$	59.1
	Mean	5.9	13.4	83.7
	SEM	1.06	2.82	
	P value	0.007	0.04	

Treatment means followed by the same letter subscript are not significantly different.

Main results mid autumn – early spring (+N):

- 'Revolution' had a higher ME yield than other ryegrasses, cocksfoot, tall fescue, 'Gala' and timothy.
- 'Bareno' brome had the highest N yield of 23.3 kg N/ha and timothy the lowest.
- 'Revolution' ryegrass and 'Bareno' brome had the highest amount of sown grass for this period (1.4 t DM/ha, Appendix 11 Botanical composition). This was 3.5 times higher than other treatments (0.4 t DM/ha).

Appendix 11. Harvest on 21 October 2008. Regrowth period 12/9-21/10/08 (39 days). Pastures received 50 kg N/ha on 10/9/08.

Species	Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Ryegrass	'Aries HD' 5 kg/ha	11.7	21.0	131
	'Aries HD' 10 kg/ha	8.7	17.5	109
	'Aries HD' 15 kg/ha	9.8	17.9	111
	'Cannon LE'	9.7	16.2	101
	'Revolution'	9.6	16.4	102
Brome	'Bareno'	8.5	25.6	160
	'Gala'	4.5	12.1	75.6
Cocksfoot	'Kara'	9.4	25.3	158
Tall fescue	'Advance'	5.6	15.3	95.9
Timothy	'Viking'	13.3	26.3	164
	Mean	9.6	20.9	121
	SEM	2.26	3.81	
	P value	0.464	0.109	

Main results early spring – mid spring (+N):

- 50 kg/ha of nitrogen applied as urea on 10/9/2008.
- The ME yield averaged 9.6 GJ/ha and N was 20.9 kg/ha.
- The ME (9.6 GJ/ha) would support 9.1 SU/ha over 39 days.

Appendix 12. Harvest on 21 April 2009. Regrowth period 29/1-21/4/09 (82days).

Species	Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Ryegrass	'Aries HD' 5 kg/ha	5.9	9.7	60.8
	'Aries HD' 10 kg/ha	2.7	3.9	24.3
	'Aries HD' 15 kg/ha	3.8	6.5	40.4
	'Cannon LE'	4.2	6.4	39.8
	'Revolution'	6.3	8.6	53.7
Brome	'Bareno'	4.7	10.2	63.7
	'Gala'	-	-	-
Cocksfoot	'Kara'	-	-	-
Tall fescue	'Advance'	-	-	-
Timothy	'Viking'	5.9	9.7	60.8
	Mean	4.7	7.9	49.4
	SEM	1.82	3.36	
	P value	0.417	0.561	

Note: - = insufficient sample for NIRS.

Main results mid summer – late autumn:

- The mean ME yield was 4.7 GJ/ha and N yield was 7.9 kg/ha.
- The 50 kg N applied had little impact on the DM, ME or N yield due to low spring rainfall (43 mm).

Legume and Herbs

Background

- From the 8-13th of February 2006 eight legume and herbs species were sown: Alsike (3.5 kg/ha), 'Demand' white (4 kg/ha),'Pawera' red (5kg/ha), 'Leura' subterranean (10 kg/ha),'Bolta' balansa (3 kg/ha) clovers, 'Choice' chicory (0.6 kg/ha), 'Tonic' plantain (1 kg/ha) and 'Kaituna' lucerne (10 kg/ha) (eight treatments with four replicates).
- 1st of November 2006: 'Endura' Caucasian clover (Cc) was over drilled at 8 kg/ha in chicory and plantain treatments and sown with rape (0.5 kg/ha) as a cover crop.
- Grazing occurred in November 2007, April, October 2008 and January 2009.
- Maintenance fertiliser (superphosphate) was applied October 2007 (750 kg/ha) and September 2008 (300 kg/ha). February 2008 urea applied at 100 kg/ha.
- Spinnaker (300 ml/ha) and Codacide (adjuvant oil) at 500 ml/ha were sprayed in May 2008 to reduce unsown species.

New sowing on 28th February 2008

- All legume plots were oversown with a strip (9 x 10 m) of 'Bronsyn AR1' perennial ryegrass (10 kg/ha), 'Dg25' cocksfoot (2 kg/ha), subterranean ('Denmark' 10 kg/ha) and strawberry clover ('Lucila' 2 kg/ha).
- Fallow plots were sown with a mix of subterranean ('Denmark' 10 kg/ha) and strawberry clover ('Lucila' 2 kg/ha) as a mix.
- In most harvests lucerne yield has been disappointing and further experiments have been established to investigate why.

Annual nutritive yield: Year 2

Appendix 13. Annual ME, N and protein yields for Year 2: 1/7/07-8/4/08 (282 days). Harvested on: 20/11/07 and 8/4/08.

Species	Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Lucerne	'Kaituna'	8.4 $_{bc}$	23.9 $_{c}$	149
Red clover	'Pawera'	26.2 $_{a}$	84.6 $_{a}$	528
White clover	'Demand'	21.5 $_{a}$	68.7 $_{ab}$	429
Caucasian clover (Cc)	'Endura'	21.0 $_{a}$	61.9 $_{ab}$	386
Alsike clover		18.5 $_{ab}$	60.1 $_{ab}$	375
Subterranean	'Leura'	3.6 $_{c}$	8.3 $_{c}$	51.6
Balansa	'Bolta'	7.0 $_{c}$	21.1 $_{c}$	132
Chicory	'Choice'	7.3 $_{c}$	15.7 $_{c}$	98.1
Plantain	'Tonic'	21.2 $_{a}$	37.7 $_{bc}$	235
	Mean	15.0	42.5	265
	SEM	3.50	32.80	
	P value	<0.001	<0.001	

Treatment means followed by the same letter subscript are not significantly different.

Main results:

- Red, white, Caucasian and alsike clovers and plantain had higher ME yields than the annual clovers and chicory.
- Red clover had a higher N yield (84.6 kg/ha) than lucerne, annual clovers and herbs.

Annual nutritive yield: Year 3

Appendix 14. Annual ME, N% and protein yields for year 3:1/7/08-21/4/09 (294 days). Harvested on: 21/10/08, 14/1/09 and 21/4/09.

Species	Cultivar		ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Lucerne	'Kaituna'		15.4 $_{bc}$	53.4 $_{bc}$	334
Red clover	'Pawera'		31.3 $_{a}$	107.4 $_{a}$	671
White clover	'Demand'		31.5 $_{a}$	108.0 $_{a}$	675
Caucasian clover (Cc)	'Endura'		20.2 $_{b}$	67.8 $_{b}$	423
Alsike clover			16.4 $_{bc}$	53.6 $_{bc}$	335
Subterranean	'Leura'		4.9 $_{d}$	14.4 $_{d}$	89.8
Balansa	'Bolta'		11.1 $_{bcd}$	41.4 $_{bcd}$	258
Chicory	'Choice'		3.3 $_{d}$	8.9 $_{d}$	55.6
Plantain	'Tonic'		17.1 $_{bc}$	35.2 $_{bcd}$	220
Strawberry & Subterranean	'Lucila'		2.7 $_{d}$	9.6 $_{d}$	60.3
	'Denmark'		8.0 $_{cd}$	21.9 $_{cd}$	137
		Mean	14.7	47.4	296
		SEM	3.39	11.5	
		P value	<0.001	<0.001	

Treatment means followed by the same letter subscript are not significantly different.

Main results:

- White and red clover had higher ME (31.4 GJ/ha) and N (108 kg/ha) yields than all other species.
- Mean ME were similar for Year 2 (Appendix 13) and 3 (Appendix 14).

Individual Harvests: Year 2

Appendix 15. Harvest on 20 November 2007. Regrowth period: 30/6-20/11/07 (143 days).

Species	Cultivar		ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Lucerne	'Kaituna'		4.8 $_{bc}$	14.1 $_{c}$	88.1
Red clover	'Pawera'		16.6 $_{a}$	55.3 $_{a}$	345
White clover	'Demand'		12.9 $_{a}$	44.3 $_{ab}$	276
Caucasian clover (Cc)	'Endura'		16.8 $_{a}$	50.6 $_{a}$	316
Alsike clover			13.6 $_{a}$	45.9 $_{ab}$	286
Subterranean	'Leura'		3.3 $_{c}$	7.3 $_{c}$	45.7
Balansa	'Bolta'		4.7 $_{bc}$	16.1 $_{c}$	100
Chicory	'Choice'		3.7 $_{c}$	8.3 $_{c}$	51.7
Plantain	'Tonic'		11.1 $_{ab}$	22.9 $_{bc}$	143
		Mean	9.7	29.3	183
		SEM	2.57	8.09	
		P value	0.001	<0.001	

Treatment means followed by the same letter subscript are not significantly different.

Main results mid winter – end of spring:

- Perennial clovers had higher ME yields (15.0 GJ/ha) compared with the other treatments (5.5 GJ/ha). This was due to the higher DM yields from perennial clovers (1260 kg DM/ha of sown clover) compared with 352 kg DM/ha for other treatments (Appendix 17; Botanical composition).
- Red and Caucasian clovers had the highest N yields (53.0 kg/ha).
- The longer recovery period of legumes and herbs after grazing, limited the estimated carrying capacity to 2.5 SU/ha.

Appendix 16. Harvested on 8 April 2008. Regrowth period: 1/12/07-8/4/08 (129 days).

Species	Cultivar		ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Lucerne	'Kaituna'		3.7 $_{cd}$	9.81 $_{cd}$	61.3
Red clover	'Pawera'		9.6 $_{a}$	29.3 $_{a}$	183
White clover	'Demand'		8.6 $_{ab}$	24.4 $_{ab}$	153
Caucasian clover (Cc)	'Endura'		4.2 $_{cd}$	11.3 $_{cd}$	70.4
Alsike clover			4.9 $_{bc}$	14.3 $_{bc}$	89.1
Subterranean	'Leura'		0.4 $_{d}$	0.91 $_{c}$	5.23
Balansa	'Bolta'		2.3 $_{cd}$	5.03 $_{cd}$	31.3
Chicory	'Choice'		4.2 $_{cd}$	8.5 $_{cd}$	53.0
Plantain	'Tonic'		10.1 $_{a}$	14.9 $_{bc}$	92.9
		Mean	5.3	13.1	81.9
		SEM	1.41	4.23	
		P value	<0.001	0.002	

Treatment means followed by the same letter subscript are not significantly different.

Main results early summer – mid autumn:

- Red clover and plantain had much higher ME yields than all other species, except white clover.
- Red clover had much higher N (29.3 kg/ha) yield than all other species, except white clover.

Individual Harvests: Year 3

Appendix 17. Harvested on 21 October 2008. Regrowth period: 10/4-21/10/08 (194 days).

Species	Cultivar		ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Lucerne	'Kaituna'		8.6 $_{cd}$	31.3 $_{bcd}$	196
Red clover	'Pawera'		15.2 $_{ab}$	54.1 $_{ab}$	338
White clover	'Demand'		20.2 $_{a}$	70.5 $_{a}$	441
Caucasian clover (Cc)	'Endura'		11.0 $_{bc}$	36.9 $_{bcd}$	231
Alsike clover			11.2 $_{bc}$	36.2 $_{bcd}$	226
Subterranean	'Leura'		4.50 $_{cd}$	12.8 $_{cde}$	79.9
Balansa	'Bolta'		11.1 $_{bc}$	41.4 $_{bc}$	259
Chicory	'Choice'		1.42 $_{d}$	3.61 $_{e}$	22.5
Plantain	'Tonic'		9.2 $_{bc}$	20.0 $_{cde}$	125
Strawberry &	'Lucila'		-	-	-
Subterranean	'Denmark'		4.9 $_{cd}$	12.2 $_{de}$	76.4
		Mean	9.7	31.9	199
		SEM	2.54	9.16	
		P value	<0.001	<0.001	

Treatment means followed by the same letter subscript are not significantly different. Note - = insufficient sample for NIRS.

Main results mid autumn – mid spring:

- ME yield ranged from 1.4 (chicory) to 20.2 GJ/ha (white clover).
- White clover had the highest N yield (70.5 kg/ha) followed by red clover.
- With a mean ME yield of 9.7 GJ/ha these pastures would carry 1.9 SU/ha over 194 days.

Appendix 18. Harvested on 14 January 2009. Regrowth period: 7/11/08-14/1/09 (68 days).

Species	Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Lucerne	'Kaituna'	3.7 $_{cde}$	12.4 $_{cde}$	77.8
Red clover	'Pawera'	12.8 $_{a}$	41.2 $_{a}$	258
White clover	'Demand'	8.6 $_{b}$	27.6 $_{b}$	173
Caucasian clover (Cc)	'Endura'	6.7 $_{bc}$	22.7 $_{bc}$	142
Alsike clover		4.3 $_{cd}$	14.3 $_{cd}$	89.4
Subterranean	'Leura'	-	-	-
Balansa	'Bolta'	-	-	-
Chicory	'Choice'	1.9 $_{de}$	5.3 $_{de}$	33.1
Plantain	'Tonic'	3.4 $_{de}$	7.2 $_{de}$	45.2
Strawberry &	'Lucila'	-	-	-
Subterranean	'Denmark'	0.7 $_{e}$	1.9 $_{e}$	12.0
	Mean	5.3	16.6	104
	SEM	1.12	3.50	
	P value	<0.001	<0.001	

Treatment means followed by the same letter subscript are not significantly different. Note - = insufficient sample for NIRS.

Main results late spring – mid summer:

- Red clover had the higher ME (12.8 GJ/ha) and N (41.2 kg/ha) yield than other species.
- 'Leura' subterranean clover failed to regenerate.

Appendix 19. Harvest on 21 April 2009. Regrowth period: 14/1-21/4/08 (81 days).

Species	Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Lucerne	'Kaituna'	3.0 $_{ab}$	9.7 $_{a}$	60.3
Red clover	'Pawera'	3.3 $_{ab}$	12.1 $_{a}$	75.6
White clover	'Demand'	2.8 $_{ab}$	10.0 $_{a}$	62.2
Caucasian clover (Cc)	'Endura'	2.5 $_{bc}$	8.1 $_{ab}$	50.9
Alsike clover		0.8 $_{cd}$	3.1 $_{bc}$	19.3
Subterranean	'Leura'	0.3 $_{d}$	1.5 $_{c}$	7.5
Balansa	'Bolta'	-	-	-
Chicory	'Choice'	-	-	-
Plantain	'Tonic'	4.5 $_{a}$	7.9 $_{ab}$	49.6
Strawberry &	'Lucila'	2.7 $_{b}$	9.6 $_{a}$	60.3
Subterranean	'Denmark'	2.4 $_{bc}$	7.8 $_{ab}$	48.7
	Mean	2.0	6.4	40.0
	SEM	0.63	1.91	
	P value	<0.001	<0.001	

Treatment means followed by the same letter subscript are not significantly different. Note - = insufficient sample for NIRS.

Main results mid summer – late autumn:

- Plantain had the highest ME yield (4.5 GJ/ha), due to its high DM yield (550 kg/ha, Appendix 21; Botanical composition).
- Lucerne, red, white and strawberry clovers had the highest N and protein yields (10.6 GJ/ha and 65 kg/ha respectively) but overall regrowth was low.

Pasture Mixtures

- Statistics applied to grasses only. White and subterranean clovers are represented by the total mean.

Ryegrass mixtures

Background

- Sown on the 30th of January 2007 (five treatments with three replicates).
- All plots have a basal clover mixture of 'Leura' subterranean clover at 10 kg/ha and 'Nomad' white clover at 2 kg/ha. All basal clover was sown at right angles to the grass.
- Grazed November 2007 and April 2008 and 2009. Topped in January and September 2008.
- Maintenance fertiliser (superphosphate) applied October 2007 (750 kg/ha) and September 2008 (300 kg/ha). February 2008 urea applied at 100 kg urea/ha.
- Years 1 and 3 are partial years. Year 1 is from sowing to July 2007. Year 3 is from July 2008 to April 2009.
- 'Revolution' with cocksfoot has been analysed as total grass, not as individual grasses.

Annual nutritive yield : Year 2

Appendix 20. Annual ME, N and protein yields for Year 2: 6/9/07-8/4/08 (215 days). Harvested on: 20/11/07 and 8/4/08.

Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
White clover	*18.5*	*56.3*	*352*
Subterranean clover	*4.37*	*4.62*	*28.9*
'Revolution' AR1 10 kg/ha	21.3 $_{b}$	32.7 $_{b}$	205
'Revolution' AR1 20 kg/ha	41.3 $_{a}$	60.7 $_{a}$	380
'Revolution' AR1 10 kg/ha &	21.9 $_{b}$	30.2 $_{b}$	189
'Dg25' cocksfoot	1.93 $_{c}$	3.13 $_{c}$	19.5
'Cannon' HE 10 kg/ha	26.0 $_{b}$	43.3 $_{ab}$	271
'Samson' AR1 10 kg/ha	24.6 $_{b}$	34.7 $_{b}$	217
Mean*	22.8	34.1	262.5
SEM*	3.39	5.56	
P value*	<0.001	<0.001	

Note: the means are from 6 grass treatments, however 'Revolution' 10 kg/ha and 'Dg25' cocksfoot is one treatment. * = for ryegrass/cocksfoot only.

Main results:

- Annual ME and N yield for Year 2 was highest in 'Revolution' 20 kg/ha (41.3 GJ/ha and 60.7 kg/ha). This was due to the DM yield of sown grass being higher in the 'Revolution' 20 kg/ha (2.8 t DM/ha) than other treatments (1.6 t DM/ha, Appendix 22; Botanical composition).
- The majority of the clover ME and N yields came from white clover due to its dominance in these plots (Appendix 22; Botanical composition).

Annual nutritive yield: Year 3

Appendix 21. Annual ME, N and protein yields for Year 3: 3/7/08-30/4/09 (301 days). Harvested on: 10/9/08, 21/10/08, 22/1/09 and 30/4/09.

Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
White clover	*8.39*	*27.9*	*174*
Subterranean clover	-	-	-
'Revolution' AR1 10 kg/ha	27.0 $_{a}$	44.7 $_{a}$	280
'Revolution' AR1 20 kg/ha	27.6 $_{a}$	50.1 $_{a}$	313
'Revolution' AR1 10 kg/ha &	19.1 $_{a}$	33.8 $_{a}$	211
'Dg25' cocksfoot	6.46 $_{b}$	13.7 $_{b}$	85
'Cannon' HE 10 kg/ha	21.2 $_{a}$	40.6 $_{a}$	254
'Samson' AR1 10 kg/ha	24.2 $_{a}$	43.9 $_{a}$	274
Mean*	20.9	37.8	308
SEM*	3.16	5.98	
P value*	0.008	0.018	

Note: the means are from 6 grass treatments, however 'Revolution' 10 kg/ha and 'Dg25' cocksfoot is one treatment.* = for ryegrass/cocksfoot only.

Main results:

- ME and N yields were lower from cocksfoot than the ryegrasses.
- Lower ME, N and protein for white clover in Year 3 (8.4 GJ/ha, 27.9 kg/ha and 174 kg/ha respectively) compared with Year 2 (Appendix 21) was due to ryegrass competition reducing the amount of white clover from 1.6 t DM/ha (Appendix 22, Botanical composition) to 0.8 t DM/ha (Appendix 23; Botanical composition).
- 'Leura' subterranean clover failed to regenerate.

Individual harvest: Year 1

Appendix 22. Harvested on 18 July 2007. Regrowth period: 30/1-18/7/07 (169 days).

Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
White clover	*0.3*	*0.9*	*5.63*
Subterranean clover	*1.0*	*2.8*	*17.6*
'Revolution' AR1 10 kg/ha	5.7	11.9	74.6
'Revolution' AR1 20 kg/ha	5.0	10.3	64.3
'Revolution' AR1 10 kg/ha &	3.9	8.3	51.9
'Dg25' cocksfoot	0.1	0.5	3.35
'Cannon' HE 10 kg/ha	3.2	7.4	46.2
'Samson' AR1 10 kg/ha	4.1	7.1	44.1
Mean*	4.0	8.2	51.3
SEM*	0.96	2.25	
P value*	0.179	0.298	

Note: the means are from 6 grass treatments, however 'Revolution' 10 kg/ha and 'Dg25' cocksfoot is one treatment.* = for ryegrass/cocksfoot only.

Main results sowing – mid winter:

- The mean ME yield was 4.0 GJ/ha and N was 8.2 kg/ha.
- Clover contribution at this time was negligible.

Individual harvests: Year 2

Appendix 23. Harvested on 5 November 2007. Regrowth period: 20/8-5/11/07 (77 days).

Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
White clover	*8.4*	*30.0*	*187*
Subterranean clover	*1.9*	*5.8*	*36.2*
'Revolution' AR1 10 kg/ha	7.4	12.4	77.7
'Revolution' AR1 20 kg/ha	7.8	12.3	77.0
'Revolution' AR1 10 kg/ha &	5.6	7.8	49.0
'Dg25' cocksfoot	-	-	-
'Cannon' HE 10 kg/ha	6.4	10.2	63.5
'Samson' AR1 10 kg/ha	3.8	4.5	28.3
Mean*	6.2	9.5	59.4
SEM*	1.50	2.04	
P value*	0.403	0.111	

Note: the means are from 6 grass treatments, however 'Revolution' 10 kg/ha and 'Dg25' cocksfoot is one treatment.* = for ryegrass/cocksfoot only.

Main results late winter - late spring:

- The ME yield mean was 6.2 GJ/ha for grasses and 8.4 GJ/ha for white clover.
- Nitrogen averaged 9.5 kg/ha from grasses and 30 kg/ha for white clover.
- The low subterranean clover yield resulted from its low DM yield (Appendix 25; Botanical composition).
-

Appendix 24. Harvested on 20 November 2007. Regrowth period 20/8-20/11/07 (92 d).

Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
White clover	*14.6*	*46.7*	*291*
Subterranean clover	*4.4*	*9.6*	*60.2*
'Revolution' AR1 10 kg/ha	7.4 $_{bc}$	10.4 $_{bc}$	64.8
'Revolution' AR1 20 kg/ha	21.0 $_{a}$	27.3 $_{a}$	171
'Revolution' AR1 10 kg/ha &	7.8 $_{bc}$	9.8 $_{bc}$	61.4
'Dg25' cocksfoot	1.0 $_{c}$	1.6 $_{c}$	10.1
'Cannon' HE 10 kg/ha	13.4 $_{ab}$	18.4 $_{ab}$	115
'Samson' AR1 10 kg/ha	12.6 $_{ab}$	17.4 $_{ab}$	109
Mean*	10.5	14.2	88.8
SEM*	3.20	4.09	
P value*	0.021	0.018	

Note: the means are from 6 grass treatments, however 'Revolution' 10 kg/ha and 'Dg25' cocksfoot is one treatment.* = for ryegrass/cocksfoot only.

Main results late winter – end of spring:

- 'Revolution' at 20 kg/ha had the highest ME yield (21.0 GJ/ha) and N (27.3 kg/ha), due to its higher DM yield of sown grass (1635 kg/ha) compared with 935 kg DM/ha for other treatments (Appendix 26, Botanical composition).
- White clover produced 1228 kg DM/ha compared with subterranean 400 kg DM/ha and therefore had a higher yield of ME yield (14.6 GJ/ha) and N (46.7 kg/ha).
- The combined grass and clovers with a mean ME yield of 29.5 GJ/ha would carry 11.9 SU/ha over 92 days.

Appendix 25. Harvested on 8 April 2008. Regrowth period: 17/1-8/4/08 (82 days).

Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
White clover	*3.9*	*9.5*	*59.7*
Subterranean clover	-	-	-
'Revolution' AR1 10 kg/ha	8.42 $_{b}$	11.0	68.8
'Revolution' AR1 20 kg/ha	14.3 $_{a}$	20.8	129
'Revolution' AR1 10 kg/ha & 'Dg25' cocksfoot	11.2 $_{ab}$	15.5	96.9
	0.92 $_{c}$	1.51	9.42
'Cannon' HE 10 kg/ha	9.32 $_{ab}$	18.9	118
'Samson' AR1 10 kg/ha	7.51 $_{b}$	10.3	64.2
Mean*	8.6	13.0	81.3
SEM*	1.80	3.87	
P value*	0.007	0.052	

Note: the means are from 6 grass treatments, however 'Revolution' 10 kg/ha and 'Dg25' cocksfoot is one treatment.*= for ryegrass/cocksfoot only. - = no sample from botanical composition.

Main results mid summer – mid autumn:

- ME yield from cocksfoot was lower than all other grasses.
- The mean N yield was only 13.0 kg/ha for sown grasses.
- White clover yield (340 kg DM/ha) was lower than grasses (830 kg DM/ha, Appendix 27, Botanical composition) and therefore ME yield (3.9 GJ/ha) and N yield (9.5 kg/ha) was also lower than grasses.

Individual harvest: Year 3

Appendix 26. Harvest on 2 July 2008. Regrowth period: 12/4-2/7/08 (81 days).

Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
White clover	-	-	-
Subterranean clover	-	-	-
'Revolution' AR1 10 kg/ha	5.5	11.4	71.1
'Revolution' AR1 20 kg/ha	6.0	12.6	79.0
'Revolution' AR1 10 kg/ha & 'Dg25' cocksfoot	2.8	4.89	30.3
	-	-	-
'Cannon' HE 10 kg/ha	3.4	6.02	37.6
'Samson' AR1 10 kg/ha	4.5	6.95	43.4
Mean*	4.4	8.37	
SEM*	0.88	1.96	
P value*	0.138	0.083	

Note: the means are from 6 grass treatments, however 'Revolution' 10 kg/ha and 'Dg25' cocksfoot is one treatment.* = for ryegrass/cocksfoot only. - = insufficient sample for NIRS.

Main results mid autumn – mid winter:

- ME yield for grasses was 4.4 GJ/ha and N yield averaged 8.37 kg/ha.

Appendix 27. Harvested on 10 September 2008. Regrowth period: 12/4-10/9/08 (151 d).

Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
White clover	*0.1*	*0.5*	*3.12*
Subterranean clover	-	-	-
'Revolution' AR1 10 kg/ha	5.6	12.4	77.5
'Revolution' AR1 20 kg/ha	8.2	18.7	117
'Revolution' AR1 10 kg/ha &	5.5	12.1	75.8
'Dg25' cocksfoot	-	-	-
'Cannon' HE 10 kg/ha	5.6	16.7	105
'Samson' AR1 10 kg/ha	7.0	17.3	108
Mean*	6.4	15.5	96.8
SEM*	1.22	3.19	
P value*	0.485	0.515	

Note: the means are from 6 grass treatments, however 'Revolution' 10 kg/ha and 'Dg25' cocksfoot is one treatment.* = for ryegrass/cocksfoot only. - = no sample from botanical composition or insufficient sample for NIRS.

Main results mid autumn – early spring:

- The mean yield for ME was 6.4 GJ/ha and 15.5 kg/ha for nitrogen.

Appendix 28. Harvest on 21 October 2008. Regrowth period: 12/9/-21/10/08 (39 days).

Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
White clover	*7.6*	*26.1*	*163*
Subterranean clover	-	-	-
'Revolution' AR1 10 kg/ha	10.1	14.9	93.3
'Revolution' AR1 20 kg/ha	11.3	15.2	95.0
'Revolution' AR1 10 kg/ha &	9.1	13.6	85.2
'Dg25' cocksfoot	1.5	2.7	16.6
'Cannon' HE 10 kg/ha	9.3	12.9	80.3
'Samson' AR1 10 kg/ha	9.5	13.9	86.9
Mean*	8.5	12.2	76.3
SEM*	2.20	3.55	
P value*	0.099	0.203	

Note: the means are from 6 grass treatments, however 'Revolution' 10 kg/ha and 'Dg25' cocksfoot is one treatment.* = for ryegrass/cocksfoot only. - = no sample from botanical composition or insufficient sample for NIRS.

Main results early spring – mid spring:

- The mean ME for grasses was 8.5 kg/ha.
- The mean N and protein were 12.2 kg/ha and 76.3 kg/ha respectively for grasses.
- The mean ME and N yields for white clover were 7.6 GJ/ha and 26.1 kg/ha respectively.
- The ME yield of grass and white clover (16.1 GJ/ha) would carry 15.3 SU/ha over 39 days.
- 'Leura' subterranean clover failed to regenerate.

Note: insufficient sample size from harvests on 21/1/09 for NIRS and hence no results. White clover sample size was insufficient from the 'Revolution' and cocksfoot treatment on 18/3/09 (Appendix 30), therefore remaining treatments used (n=4).

Appendix 29. Harvested on 19 March 2009. Regrowth period: 22/1-19/3/09 (49 days).

Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (t/ha)
White clover	*0.27*	*0.92*	*5.8*
Subterranean clover	-	-	-
'Revolution' AR1 10 kg/ha	8.0 $_{a}$	19.4 $_{a}$	121
'Revolution' AR1 20 kg/ha	5.7 $_{ab}$	10.7 $_{b}$	66.8
'Revolution' AR1 10 kg/ha &	2.2 $_{c}$	4.51 $_{b}$	28.4
'Dg25' cocksfoot	4.0 $_{bc}$	10.3 $_{b}$	64.4
'Cannon' HE 10 kg/ha	5.3 $_{ab}$	12.3 $_{ab}$	76.7
'Samson' AR1 10 kg/ha	5.5 $_{ab}$	11.3 $_{b}$	73.5
Mean*	5.1	11.5	71.9
SEM*	0.94	2.50	
P value*	0.024	0.039	

Note: the means are from 6 grass treatments, however 'Revolution' 10 kg/ha and 'Dg25' cocksfoot is one treatment.* = for ryegrass/cocksfoot only. Treatment means followed by the same letter subscript are similar. - = no sample from botanical composition.

Main results mid summer – early autumn:

- 'Revolution' established at 10 kg/ha had a higher ME yield (8.0 GJ/ha) and N (19.4 kg/ha) than other grasses.
- White clover ME and N yield was low (0.27 GJ/ha and 0.92 kg/ha respectively). This was due to low yields (22 kg/ha, Appendix 33; Botanical composition).

Appendix 30. Harvest on 30 April 2009. Regrowth period: 22/1-30/4/09 (91 days).

Cultivar	ME (GJ/ha)	N (kg/ha)	Protein (t/ha)
White clover	-	-	-
Subterranean clover	-	-	-
'Revolution' AR1 10 kg/ha	11.4	17.4	109
'Revolution' AR1 20 kg/ha	8.1	16.2	101
'Revolution' AR1 10 kg/ha &	4.6	8.1	50.4
'Dg25' cocksfoot	5.0	11.0	68.7
'Cannon' HE 10 kg/ha	6.3	11.0	68.6
'Samson' AR1 10 kg/ha	7.7	12.7	79.7
Mean*	7.2	12.7	79.4
SEM*	2.05	3.35	
P value*	0.278	0.420	

Note: the means are from 6 grass treatments, however 'Revolution' 10 kg/ha and 'Dg25' cocksfoot is one treatment.* = for ryegrass/cocksfoot only. - = no sample from botanical composition or insufficient sample for NIRS.

Main results mid summer – mid autumn:

- The mean ME yield was 7.2 GJ/ha and mean N yield was 12.7 kg/ha.

Dryland Mixtures

- Statistics applied to grasses only. White and subterranean clovers are represented by the mean of their total contribution when there was no significant difference in yield (refer to Botanical composition).

Background

- Sown on the 30th of January 2007 (five treatments with three replicates).
- All plots have a basal clover mixture of 'Leura' subterranean clover at 10 kg/ha and 'Nomad' white clover at 2 kg/ha. All basal clover was sown at right angles to the grass.
- Grazed November 2007 and April 2008 and 2009. Topped in January and September 2008.
- Maintenance fertiliser (superphosphate) applied October 2007 (750 kg/ha) and September 2008 (300 kg/ha). February 2008 urea applied at 100 kg urea/ha.
- Years 1 and 3 are partial years. Year 1 is from sowing to July 2007. Year 3 is from July 2008 to April 2009.

Annual nutritive yields : Year 2

Appendix 31. Annual ME, N and protein yields for Year 2: 6/9/07-8/4/08 (215 days). Harvested on: 20/11/07 and 8/4/08.

	ME	N	Protein
Cultivar/Species	(GJ/ha)	(kg/ha)	(kg/ha)
White clover	*24.5*	*79.4*	*496*
Subterranean clover	*7.1*	*17.9*	*112*
'Advance' tall fescue -endophyte	7.87	14.2	88.8
'Advance' Tf +endophyte	17.1	33.6	210
Agriseeds 'Dg25' cocksfoot	17.8	35.8	224
'Ella' cocksfoot	13.7	28.9	181
'Bareno' brome	22.7	56.6	354
Mean*	15.8	33.8	211
SEM*	3.67	8.82	
P value*	0.155	0.087	

Note * = for grasses only. White and subterranean clovers are represented by mean yield.

Main results:

- ME yield averaged 15.8 GJ/ha for the grasses and 31.6 GJ/ha for the additional clovers.
- Mean N yield was 34 kg/ha for grasses.
- White clover ME and N contributions were higher in dryland pastures (24.5 GJ/ha and 79.4 kg/ha respectively) than ryegrass pastures (18.5 GJ/ha and 56.3 kg /ha respectively; Appendix 20).

Annual nutritive yields : Year 3

Appendix 32. Annual ME, N and protein yields for Year 3: 3/7/08-30/4/09 (301 days). Harvested on: 10/9/08, 21/10/08, 22/1/09 and 30/4/09.

	ME	N	Protein
Cultivar/Species	(GJ/ha)	(kg/ha)	(kg/ha)
White clover	*15.0*	*50.7*	*317*
Subterranean clover	-	-	-
'Advance' tall fescue -endophyte	6.80 $_{c}$	15.4 $_{c}$	96.5
'Advance' tall fescue +endophyte	11.9 $_{c}$	28.9 $_{c}$	181
Agriseeds 'Dg25' cocksfoot	36.3 $_{a}$	91.5 $_{a}$	572
'Ella' cocksfoot	27.4 $_{b}$	71.9 $_{b}$	449
'Bareno' brome	29.3 $_{b}$	81.6 $_{ab}$	510
Mean*	22.3	57.9	362
SEM*	1.87	4.81	
P value*	<0.001	<0.001	

Treatment means followed by the same letter subscript are similar.
Note * = for grasses only.

Main results:

- 'Dg25' cocksfoot had a higher ME yield for Year 3, than all other grasses and higher N (91.5 kg/ha than all except 'Bareno'.
- White clover ME (15 GJ/ha) and N (51 kg/ha) was less than Year 2 (24.5 GJ/ha and 79.4 kg/ha respectively) (Appendix 31) due to lower DM yield (Year 2, 1300 kg/ha compared to Year 3, 740 kg/ha).
- 'Leura' subterranean clover failed to regenerate.

Individual harvest: Year 2

Appendix 33. Harvested on 18 July 2007. Regrowth period: 18/7-30/1/07 (169 days).

	ME	N	Protein
Cultivar/Species	(GJ/ha)	(kg/ha)	(kg/ha)
White clover	*0.9*	*2.7*	*17.0*
Subterranean clover	*3.2*	*9.0*	*56.4*
'Advance' tall fescue -endophyte	0.5 $_{b}$	1.0 $_{b}$	6.25
'Advance' tall fescue +endophyte	1.4 $_{b}$	2.9 $_{b}$	17.9
Agriseeds 'Dg25' cocksfoot	1.7 $_{b}$	4.8 $_{b}$	29.9
'Ella' cocksfoot	1.4 $_{b}$	3.5 $_{b}$	21.9
'Bareno' brome	5.4 $_{a}$	14.1 $_{a}$	87.9
Mean*	2.1	5.3	33.1
SEM*	0.69	1.40	
P value*	0.007	0.001	

Treatment means followed by the same letter subscript are similar.
Note * = grasses only.

Main results sowing – mid winter:

- ME and N yield was higher in 'Bareno' than all other grasses.
- Overall nutritive yields were due to low DM yield for grass (170 kg/ha, Appendix 37; Botanical composition).
- White clover yield was only 80 kg DM/ha therefore ME yield (0.9 GJ/ha) and N yield (2.7 kg/ha) was low compared to subterranean clover which had a yield of 300 kg DM/ha (Appendix 37; Botanical composition).

Appendix 34. Harvested on 5 November 2007. Regrowth period: 20/8-5/11/07 (77d).

	ME	N	Protein
Cultivar/Species	(GJ/ha)	(kg/ha)	(kg/ha)
White clover	*14.0*	*53.2*	*333*
Subterranean clover	*2.7*	*8.8*	*54.9*
'Advance' tall fescue -endophyte	2.6	7.0	43.8
'Advance' tall fescue +endophyte	3.9	9.2	57.3
Agriseeds 'Dg25' cocksfoot	1.5	4.0	25.2
'Ella' cocksfoot	1.3	3.5	22.1
'Bareno' brome	4.1	12.4	77.8
Mean*	2.7	7.2	45.0
SEM*	2.97	2.33	
P value*	0.175	0.122	

* = for grasses only.

Main results early spring – late spring:

- Mean ME yield was 2.7 GJ/ha and 7.2 kg/ha for N yield with the greatest contribution from white clover.

Appendix 35. Harvested on 20 November 2007. Regrowth period: 20/8-20/11/07 (92 d).

	ME	N	Protein
Cultivar/Species	(GJ/ha)	(kg/ha)	(kg/ha)
White clover	*18.0*	*60.1*	*375*
Subterranean clover	*3.9*	*8.9*	*55.7*
'Advance' tall fescue -endophyte	1.3	2.3	14.5
'Advance' tall fescue +endophyte	5.4	10.0	62.2
Agriseeds 'Dg25' cocksfoot	4.0	8.2	51.1
'Ella' cocksfoot	2.7	6.2	38.7
'Bareno' brome	6.0	13.2	82.6
Mean*	3.9	8.0	50.0
SEM*	1.23	2.63	
P value*	0.130	0.136	

* = for grasses only.

Main results early spring – end of spring:

- Mean ME yield was 3.9 GJ/ha and 8.0 kg/ha for N yield for grasses.
- The white clover mean ME yield was 18.0 GJ/ha and 60.1 kg/ha for N yield.
- Combining the ME from grasses and clovers (25.8 GJ/ha) would support 10.4 SU/ha for 92 days. This was lower than ryegrass mixtures for the same period (11.9 SU/ha, Appendix 25) due to the grass yield of 380 kg DM/ha in dryland pastures compared with 1050 kg DM/ha for ryegrasses (Appendix 26; Botanical composition).

Appendix 36. Harvested on 8 April 2008. Regrowth period: 17/1-8/4/08 (82 days).

Cultivar/Species	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
White clover	*5.6*	*16.6*	*104*
Subterranean clover	-	-	-
'Advance' tall fescue -endophyte	6.1	10.9	67.8
'Advance' tall fescue +endophyte	10.4	20.7	130
Agriseeds 'Dg25' cocksfoot	12.1	22.8	143
'Ella' cocksfoot	9.6	19.2	120
'Bareno' brome	11.2	29.3	183
Mean*	9.9	20.6	129
SEM*	2.80	6.77	
P value*	0.620	0.474	

* = for grasses. - = no sample from botanical composition.

Main results mid summer – mid autumn:

- ME yield averaged 9.9 GJ/ha with 20.6 kg/ha of N.
- White clover yielded 5.6 GJ/ha and 16.6 kg N/ha.

Individual harvest: Year 3

Appendix 37. Harvested on 2 July 2008. Regrowth period: 12/4-2/7/08 (81 days).

Cultivar/Species	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
White clover	*0.6*	*1.90*	*11.9*
Subterranean clover	-	-	-
'Advance' tall fescue -endophyte	0.7_{b}	1.91_{b}	11.9
'Advance' tall fescue +endophyte	1.6_{b}	4.30_{b}	26.9
Agriseeds 'Dg25' cocksfoot	4.5_{b}	11.2_{ab}	70.2
'Ella' cocksfoot	3.0_{b}	7.5_{b}	47.1
'Bareno' brome	10.0_{a}	21.9_{a}	137
Mean*	4.0	9.4	58.8
SEM*	1.22	3.87	
P value*	0.005	0.043	

* = for grasses only. - = sample size inadequate for analysis. Treatment means followed by the same letter subscript are similar

Main results mid autumn – mid winter:

- 'Bareno' had a higher yield of ME (10.0 GJ/ha) and N (21.9 kg/ha) than other grasses due to a higher grass yield (Appendix 41; Botanical composition).
- The white clover ME and N yield were lower than in April 2008 (Appendix 37) due it its lower yield in July (50 kg DM/ha; Appendix 41; Botanical composition).

Note: for the following harvests (Appendices 38-43) there was a significant difference in white clover yield amongst grass treatments (Botanical composition). Therefore white clover nutritive yields are presented within treatments. There was no subterranean clover and hence 'Clover' is for white clover only.

Appendix 38. Harvested on 10 September 2008. Regrowth period: 12/4-10/9/08 (151 days).

	ME (GJ/ha)			N (kg/ha)		
Cultivar/Species	Grass	Clover	Total	Grass	Clover	Total
'Advance' tall fescue -endophyte	1.32 $_{b}$	2.50	3.82	4.20 $_{b}$	7.99	12.2
'Advance' tall fescue +endophyte	4.62 $_{b}$	1.02	5.64	13.7 $_{b}$	3.26	17.0
Agriseeds 'Dg25' cocksfoot	9.01 $_{a}$	0.88	9.89	29.9 $_{a}$	2.82	32.7
'Ella' cocksfoot	3.41 $_{b}$	1.85	5.26	13.4 $_{b}$	5.91	19.3
'Bareno' brome	10.3 $_{a}$	3.45	13.8	32.9 $_{a}$	11.0	43.9
Mean	5.71	1.94	7.65	18.8	6.20	25.0
SEM	1.19	1.64		3.62	5.22	
P value	0.003	0.786		0.002	0.786	

Treatment means followed by the same letter subscript are similar.

Main results mid autumn – start of spring:

- 'Dg25' cocksfoot and 'Bareno' brome had the higher ME and N yields than other grasses due to their higher DM yields (Appendix 43; Botanical composition).
- White clover ME yield averaged 1.94 GJ/ha but was highest in 'Bareno', contributing to its greater total sown species ME and N.

Appendix 39. Harvest on 21 October 2008. Regrowth period: 12/9-21/10/08 (39 days).

	ME (GJ/ha)			N (kg/ha)		
Cultivar/Species	Grass	Clover	Total	Grass	Clover	Total
'Advance' tall fescue -endophyte	2.49 $_{b}$	12.5	15.0	4.99 $_{b}$	42.2	47.2
'Advance' tall fescue +endophyte	3.36 $_{b}$	9.23	12.6	6.17 $_{b}$	31.3	37.5
Agriseeds 'Dg25' cocksfoot	4.76 $_{ab}$	7.73	12.5	9.51 $_{b}$	26.2	35.7
'Ella' cocksfoot	4.74 $_{b}$	11.2	15.9	10.7 $_{b}$	38.0	48.7
'Bareno' brome	8.96 $_{a}$	4.45	13.4	19.2 $_{a}$	15.1	34.3
Mean	4.7	9.0	13.7	10.1	30.6	40.7
SEM	0.98	2.55		2.29	8.65	
P value	0.034	0.289		0.016	0.289	

Main results start of spring – mid spring:

- The ME of 8.96 GJ/ha and N yield (19.2 kg/ha) from 'Bareno' was higher than all other grasses.
- The ME mean for white clover was 9.0 GJ/ha.
- Total ME and N were 13.7 GJ/ha and 40.7 kg/ha.
- Based on the combined (grass and clover) ME yield, 13.1 SU/ha could be carried by these pastures over 39 days.

Appendix 40. Harvested on 22 January 2009. Regrowth period: 21/10/08-22/1/09 (93 days).

	ME (GJ/ha)			N (kg/ha)		
Cultivar/Species	Grass	Clover	Total	Grass	Clover	Total
'Advance' tall fescue -endophyte	2.14 $_{b}$	2.5 $_{a}$	4.62	4.56 $_{c}$	7.4 $_{a}$	12.0
'Advance' tall fescue +endophyte	1.67 $_{b}$	1.8 $_{ab}$	3.43	3.61 $_{c}$	5.2 $_{ab}$	8.81
Agriseeds 'Dg25' cocksfoot	10.4 $_{a}$	0.67 $_{b}$	11.0	22.8 $_{ab}$	2.0 $_{b}$	24.8
'Ella' cocksfoot	10.2 $_{a}$	0.84 $_{b}$	11.0	25.9 $_{a}$	2.5 $_{b}$	28.4
'Bareno' brome	5.20 $_{ab}$	0.37 $_{b}$	5.57	12.4 $_{bc}$	1.1 $_{b}$	13.5
Mean	5.90	1.22	7.12	13.9	3.65	17.6
SEM	4.60	0.443		3.43	1.33	
P value	0.010	0.05		0.005	0.05	

Treatment means followed by the same letter subscript are similar.

Main results mid spring – mid summer:

- Both cocksfoot treatments had higher ME than tall fescue.
- N yield from tall fescue with endophyte was lower than from cocksfoot.
- The white clover in the tall fescue pasture yielded more ME (2.48 GJ/ha) than other grasses due to high DM yields (Appendix 45; Botanical composition).

Appendix 41. Harvested on 19 March 2009. Regrowth period: 22/1-19/3/2009 (49 days).

	ME (GJ/ha)			N (kg/ha)		
Cultivar/Species	Grass	Clover	Total	Grass	Clover	Total
'Advance' tall fescue -endophyte	3.13 $_{c}$	0.68	3.81	9.07 $_{c}$	2.6	11.7
'Advance' tall fescue +endophyte	3.33 $_{c}$	0.92	4.25	8.57 $_{c}$	3.5	12.1
Agriseeds 'Dg25' cocksfoot	14.4 $_{a}$	0.07	14.5	38.9 $_{a}$	0.3	39.2
'Ella' cocksfoot	8.54 $_{b}$	0.33	8.87	25.7 $_{b}$	1.2	26.9
'Bareno' brome	7.66 $_{b}$	0.23	7.89	23.9 $_{b}$	0.9	24.8
Mean	7.4	0.45	7.85	21.2	1.70	22.9
SEM	1.20	0.234		3.33	0.891	
P value	<0.001	0.163		<0.001	1.70	

Treatment means followed by the same letter subscript are similar.

Main results mid summer – early autumn:

- 'Dg25' cocksfoot had the highest ME yield of 14.4 GJ/ha and N yield of 38.9 kg/ha and tall fescue the lowest.
- White clover ME yield was negligible.

Note: white clover represents the quantity from white clover in 'Advance' tall fescue with and without endophyte treatments. There was insufficient sample from other treatments for NIRS. This also occurs in Appendix 42 and 43.

Appendix 42. Harvested on 30 April 2009. Regrowth period: 22/1-30/4/09 (91 days).

	ME (GJ/ha)			N (kg/ha)		
Cultivar/Species	Grass	Clover	Total	Grass	Clover	Total
'Advance' tall fescue -endophyte	0.91 $_{d}$	0.74 $_{b}$	1.65	1.72 $_{c}$	3.0 $_{b}$	4.72
'Advance' tall fescue +endophyte	2.20 $_{d}$	1.92 $_{a}$	4.12	5.43 $_{c}$	7.8 $_{a}$	13.2
Agriseeds 'Dg25' cocksfoot	12.2 $_{a}$	0.02 $_{b}$	12.2	29.3 $_{a}$	0.1 $_{b}$	19.4
'Ella' cocksfoot	9.01 $_{b}$	0.09 $_{b}$	9.10	21.9 $_{b}$	0.4 $_{b}$	22.3
'Bareno' brome	5.92 $_{c}$	0.26 $_{b}$	6.18	17.2 $_{b}$	1.1 $_{b}$	18.3
Mean	6.0	0.60	6.60	15.1	2.5	17.6
SEM	0.73	0.294		1.95	1.20	
P value	<0.001	0.009		<0.001	0.009	

Treatment means followed by the same letter subscript are similar.

Main results mid summer – mid autumn:

- 'Dg25' cocksfoot had the highest ME of 12.2 GJ/ha and N yields (29.3 kg/ha).

Timothy Mixtures

There was insufficient sample from individual pastures for NIRS, therefore treatment means are presented. Plantain and chicory values are from treatments with the herbs sown separately and together.
Missing values (-) represent insufficient sample for NIRS or no sample present in botanical composition.

Background

- Sown on the 30th of January 2007 (five treatments with three replicates).
- All plots have a basal clover mixture of 'Leura' subterranean clover at 10 kg/ha and 'Nomad' white clover at 2 kg/ha. All basal clover was sown at right angles to the grass.
- Grazed November 2007 and April 2008 and 2009. Topped in January 2008.
- Maintenance fertiliser (superphosphate) applied October 2007 (750 kg/ha) and September 2008 (300 kg/ha). February 2008 urea applied at 100 kg urea/ha.
- Years 1 and 3 are partial years. Year 1 is from sowing to July 2007. Year 3 is from July 2008 to April 2009.

Annual nutritive yields: Year 2

Appendix 43. Annual timothy, clovers, herbs, unsown species and dead yields for Year 2: 6/9/07-8/4/2008 (215 days). Harvested on: 20/11/07 and 8/4/08.

	ME	N	Protein
Species	(GJ/ha)	(kg/ha)	(kg/ha)
Timothy	3.01	5.61	35.0
White clover	21.6	68.0	425
Subterranean clover	16.0	9.80	61.4
Red clover	0.44	9.46	58.6
Chicory	4.31	9.01	56.2
Plantain	6.55	17.7	111

Annual nutritive yields: Year 3

Appendix 44. Annual timothy, clovers, herbs, unsown species and dead yields for Year 3: 1/7/08-30/4/09 (303 days). Harvested on: 21/10/08, 22/1/09 and 30/4/09.

	ME	N	Protein
Species	(GJ/ha)	(kg/ha)	(kg/ha)
Timothy	4.30	8.13	51.2
White clover	10.8	36.9	231
Subterranean clover	-	-	-
Red clover	1.52	4.96	31.1
Chicory	1.80	4.40	28.3
Plantain	19.1	38.3	238

Note: - = No sample from botanical composition.

Individual Harvests: Year 1

Appendix 45. Harvested on 18 July 2007. Regrowth period: 30/1-18/7/07 (169 days).

Species	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Timothy	0.21	0.51	3.11
White clover	0.20	0.69	4.15
Subterranean clover	0.20	2.70	17.0
Red clover	0.20	0.50	3.12
Chicory	0.13	0.32	2.00
Plantain	0.32	0.83	5.21

Individual Harvests: Year 2

Appendix 46. Harvested on 5 November 2007. Regrowth period: 20/8-5/11/07 (77 days).

Species	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Timothy	0.70	1.72	10.5
White clover	13.2	49.0	311
Subterranean clover	13.1	8.13	50.9
Red clover	3.10	8.56	53.7
Chicory	-	-	-
Plantain	1.89	4.60	28.6

Note: - = insufficient sample for NIRS.

Appendix 47. Harvested on 20 November. Regrowth period: 20/8-20/11/07 (92 days).

Species	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Timothy	2.80	5.14	32.1
White clover	16.2	52.0	323
Subterranean clover	16.0	9.77	61.1
Red clover	3.10	8.56	53.7
Chicory	3.32	6.71	39.7
Plantain	3.33	5.02	31.2

Appendix 48. Harvested on 8 April 2008. Regrowth period: 1/12/07-8/4/08 (129 days).

Species	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Timothy	0.21	0.49	3.42
White clover	5.62	15.9	100
Subterranean clover	-	-	-
Red clover	0.30	0.91	5.34
Chicory	1.04	2.30	14.5
Plantain	6.31	12.7	79.1

Note: - = No sample from botanical composition.

Individual Harvests: Year 3

Appendix 49. Harvested on 21 October 2008. Regrowth period: 12/4-21/10/08 (192 days).

Species	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Timothy	3.01	5.02	31.1
White clover	7.72	26.0	165
Subterranean clover	-	-	-
Red clover	1.49	4.97	31.2
Chicory	1.15	2.60	16.0
Plantain	6.60	14.9	93.0

Note - = No sample from botanical composition.

Appendix 50. Harvested on 22 January 2009. Regrowth period: 7/11/08-22/1/09 (76 days).

Species	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Timothy	0.30	0.91	5.29
White clover	1.59	5.03	31.3
Subterranean clover	-	-	-
Red clover	-	-	-
Chicory	0.20	0.49	2.90
Plantain	3.64	7.71	48.1

Note: - = No sample from botanical composition or insufficient sample for NIRS.

Appendix 51. Harvested on 19 March 2009. Regrowth period: 22/1-19/3/09 (49 days).

Species	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Timothy	0.46	1.66	10.4
White clover	1.10	4.16	25.4
Subterranean clover	-	-	-
Red clover	-	-	-
Chicory	2.47	8.02	49.2
Plantain	10.0	26.0	161

Note: - = No sample from botanical composition or insufficient sample for NIRS.

Appendix 52. Harvested on 30 April 2009. Regrowth period: 22/1-30/4/09 (91 days).

Species	ME (GJ/ha)	N (kg/ha)	Protein (kg/ha)
Timothy	1.01	2.23	13.7
White clover	1.48	5.90	37.1
Subterranean clover	-	-	-
Red clover	-	-	-
Chicory	0.40	1.31	7.92
Plantain	8.81	15.4	96.0

Note: - = No sample from botanical composition or insufficient sample for NIRS.

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