

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 1 – Botanical Composition

Prepared by
Dr Derrick Moot
Professor of Plant Science
Lincoln University
New Zealand

August 2009

Appendices – Botanical Composition.

Perennial Grasses

- Total yield represents yield at the end of a rotation (i.e. prior to grazing). Standing yield represent mid rotation measurements. Both yield measurements are determined from destructive harvests of a 0.2m² quadrat cut to ground level in each plot. Subsamples were taken and dissected into sown species, weed and dead components to determine botanical composition (Cayley and Bird 1996).

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 Yields: 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. Grass, unsown and dead yields for Year 2 (+N): 1/7/2007-8/4/2008 (282 days). Harvested on: 20/11/07 and 8/4/08.

Species	Cultivar	Yield (t DM/ha)		
		Grass	Unsown species	Dead
Ryegrass	'Aries HD' 5 kg/ha	3.1 _b	0.8	1.3
	'Aries HD' 10 kg/ha	3.7 _b	0.8	1.7
	'Aries HD' 15 kg/ha	3.6 _b	0.7	0.9
	'Cannon LE'	3.6 _b	1.0	1.5
	'Revolution'	5.6 _a	1.0	1.1
Brome	'Bareno'	3.6 _b	0.5	0.7
	'Gala'	1.1 _c	1.3	1.3
Cocksfoot	'Kara'	3.3 _b	0.9	1.6
Tall fescue	'Advance'	2.6 _b	1.2	0.7
Timothy	'Viking'	3.3 _b	0.7	0.9
	Mean	3.4	0.9	1.2
	SEM	0.455	0.194	0.258
	P value	<0.001	0.128	0.083

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

Main results:

- Annual grass yield ranged from 1.1 ('Gala') to 5.6 t DM/ha ('Revolution').
- The mean for unsown species was 0.9 t DM/ha and 1.2 t DM/ha for dead.

Appendix 2. Grass, unsown and dead yields for spring 2007 (-N): 1/7/-20/11/2007 (142 days). Harvested on: 20/11/2007.

Species	Cultivar	Yield (t DM/ha)		
		Grass	Unsown species	Dead
Ryegrass	'Aries HD' 5 kg/ha	1.3	0.1 _b	0.6 _a
	'Aries HD' 10 kg/ha	0.9	0.0 _b	0.5 _{ab}
	'Aries HD' 15 kg/ha	0.8	0.1 _b	0.4 _{ab}
	'Cannon LE'	1.2	0.0 _b	0.4 _{ab}
	'Revolution'	1.1	0.0 _b	0.2 _{bc}
Brome	'Bareno'	1.1	0.1 _b	0.1 _c
	'Gala'	0.6	0.5 _a	0.5 _{ab}
Cocksfoot	'Kara'	0.8	0.4 _a	0.4 _{abc}
Tall fescue	'Advance'	1.0	0.1 _b	0.5 _a
Timothy	'Viking'	1.0	0.2 _b	0.2 _{bc}
	Mean	1.0	0.1	0.4
	SEM	0.187	0.714	0.109
	P value	0.334	<0.001	0.039

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

Main results:

- The grass mean yield for no nitrogen treatments was 1.0 t DM/ha.
- Unsown species ranged from being negligible in the ryegrass, 'Bareno' and tall fescue plots to 0.4 t/ha in cocksfoot and 0.5 t/ha for 'Gala'.

Annual Yields: Year 3

**Appendix 3. Grass, unsown and dead yields for Year 3: 2/7/2008-21/4/2009 (293 days).
Harvested on: 10/9/08, 21/10/08, 14/1/09 and 21/4/09.**

Species	Cultivar	Yield (t DM/ha)		
		Grass	Unsown species	Dead
Ryegrass	'Aries HD' 5 kg/ha	1.1 _{bcd}	1.5	1.0 _{ab}
	'Aries HD' 10 kg/ha	1.2 _{abc}	1.3	0.7 _{bc}
	'Aries HD' 15 kg/ha	1.5 _{abc}	1.2	0.7 _{bc}
	'Cannon LE'	1.2 _{abc}	1.4	0.7 _{bc}
	'Revolution'	1.7 _a	1.7	1.0 _{ab}
Brome	'Bareno'	1.6 _{ab}	1.7	1.3 _a
	'Gala'	0.6 _d	1.5	1.1 _{ab}
Cocksfoot	'Kara'	1.4 _{abc}	1.6	1.1 _{ab}
Tall fescue	'Advance'	1.3 _{abc}	1.6	0.9 _{ab}
Timothy	'Viking'	1.0 _{cd}	1.2	0.4 _c
	Mean	1.2	1.5	0.9
	SEM	0.194	0.173	0.152
	P value	0.019	0.321	0.023

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

Main results:

- Grass yield ranged from 0.6 ('Gala') to 1.7 t DM/ha ('Revolution').
- The mean yield for unsown species was 1.5 t DM/ha and 0.9 t DM/ha for dead. The main unsown species present was browntop.
- Grass yield for Year 3 was lower (1.2 t DM/ha) than for Year 2 (3.4 t DM/ha).

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 August 2007. The remaining half received no nitrogen (-N).
- In spring mid-rotation harvests for +N were made on 1 and 25 October, 5 November. The end of rotation harvest was on 20 November 2007. The final harvest for the year was made on 8 April 2008.
- Harvests for -N on 25 October (mid rotation) and 20 November 2007 (end of rotation).

Appendix 4. Harvested on 1 October 2007 (+ N) regrowth period: 15/8/-1/10/2007 (47 days).

Species	Cultivar	Botanical Composition (%)			Standing Yield (kg DM/ha)
		Grass	Unsown species	Dead	
Ryegrass	'Aries HD' 5 kg/ha	62	4	34	1144 _{abcd}
	'Aries HD' 10 kg/ha	79	0	21	791 _d
	'Aries HD' 15 kg/ha	64	3	33	1169 _{abcd}
	'Cannon LE'	72	4	24	1205 _{abcd}
	'Revolution'	89	1	10	1469 _{ab}
Bromes	'Bareno'	53	9	38	1491 _{ab}
	'Gala'	67	13	20	983 _{cd}
Cocksfoot	'Kara'	77	8	15	1405 _{abc}
Tall fescue	'Advance'	59	17	24	1043 _{bcd}
Timothy	'Viking'	83	9	8	1517 _a
	Mean	70	7	23	1220
	SEM	10.5	5.16	9.01	157
	P value	0.334	0.418	0.301	0.037

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

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

- Yield ranged from 790 ('Aries HD' 10 kg/ha) to 1520 kg DM/ha (timothy).
- Perennial ryegrass had 2% of unsown species compared with 11% from all other treatments, most likely due to its rapid establishment suppressing invading browntop.
- High proportion of dead material (23%) reflects grazing could occur earlier.

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

Species	Cultivar	Botanical Composition (%)			Standing Yield (kg DM/ha)
		Grass	Unsown species	Dead	
Ryegrass	'Aries HD' 5 kg/ha	70	3	27 _{ab}	2280
	'Aries HD' 10 kg/ha	86	6	8 _c	1855
	'Aries HD' 15 kg/ha	79	4	17 _{bc}	2024
	'Cannon LE'	61	7	32 _a	2928
	'Revolution'	80	4	16 _{bc}	2219
Brome	'Bareno'	82	8	10 _c	1499
	'Gala'	59	5	36 _a	2287
Cocksfoot	'Kara'	58	16	26 _{ab}	2333
Tall fescue	'Advance'	70	5	25 _{ab}	2506
Timothy	'Viking'	74	2	24 _{bc}	3080
	Mean	69	6	23	2190
	SEM	8.14	3.26	4.09	256
	P value	0.256	0.246	0.007	0.290

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

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

- The yield ranged from 1.5 ('Bareno') to 3.0 t DM/ha (timothy) with a mean of 2.2 t/ha.
- The mean composition of sown grass was 69% and 6% for unsown species.

Appendix 6. Harvested on 25 October 2007 (- N) regrowth period: 15/8/-25/10/2007 (71 days).

Species	Cultivar	Botanical Composition (%)			Standing Yield (kg DM/ha)
		Grass	Unsown species	Dead	
Ryegrass	'Aries HD' 5 kg/ha	56 _{cde}	3 _c	41 _{ab}	531
	'Aries HD' 10 kg/ha	48 _{de}	2 _c	50 _a	553
	'Aries HD' 15 kg/ha	53 _{cde}	1 _c	46 _{ab}	653
	'Cannon LE'	59 _{cd}	7 _{bc}	34 _{bc}	1057
	'Revolution'	84 _a	1 _c	15 _d	805
Brome	'Bareno'	80 _{ab}	4 _{bc}	16 _d	889
	'Gala'	38 _e	22 _a	40 _{ab}	877
Cocksfoot	'Kara'	46 _{de}	18 _{ab}	36 _{abc}	935
Tall fescue	'Advance'	64 _{bcd}	3 _c	33 _{bc}	822
Timothy	'Viking'	73 _{abc}	3 _c	24 _{cd}	718
	Mean	60	6	34	780
	SEM	6.7	4.7	5.06	200
	P value	0.002	0.048	0.001	0.691

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

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

- The mean yield was 780 kg DM/ha.
- Grass proportion was higher in the later sown (November 2006) 'Revolution' than the other ryegrasses, cocksfoot, tall fescue, timothy and 'Gala'.
- 'Gala' had the highest unsown species (22%).
- 'Gala' grass proportion decreased from 59% with N (Appendix 5) to 38% (Appendix 6) without N and there was an increase in unsown species from 5 to 22%.
- Standing DM yield was 2.8 times greater with the addition of N (2190 kg DM/ha by +N pastures compared with 780 kg DM/ha by -N pastures) (Appendix 5 and Appendix 6).

Appendix 7. Harvested on 5 November 2007 (+N) regrowth period: 15/8/-5/11/2007 (82 days).

Species	Cultivar	Botanical Composition (%)			Standing Yield (kg DM/ha)
		Grass	Un-sown species	Dead	
Ryegrass	'Aries HD' 5 kg/ha	67 _{abc}	10	23	3294
	'Aries HD' 10 kg/ha	70 _{abc}	2	28	3377
	'Aries HD' 15 kg/ha	75 _{ab}	2	23	3383
	'Cannon LE'	65 _{bcd}	10	25	3537
	'Revolution'	74 _{abc}	2	24	4151
Brome	'Bareno'	86 _a	3	11	2669
	'Gala'	46 _d	24	30	2672
Cocksfoot	'Kara'	68 _{abc}	9	23	3480
Tall fescue	'Advance'	60 _{cd}	14	26	3499
Timothy	'Viking'	75 _{ab}	3	22	3128
	Mean	69	8	23	3320
	SEM	6.7	5.15	4.62	305
	P value	0.031	0.083	0.365	0.078

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

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

- Standing yield ranged from 3.1 (timothy) to 4.1 t DM/ha ('Revolution').
- Sown grass proportion was highest in 'Bareno' (86%) and lowest in 'Gala' (46%) bromes.
- Mean standing DM yield for 5/11/07 +N was 3.3 t DM/ha compared with 2.2 t DM/ha on 25/10/07 +N (Appendix 5).

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

Species	Cultivar	Botanical Composition (%)			Total Yield (kg DM/ha)
		Grass	Un-sown species	Dead	
Ryegrass	'Aries HD' 5 kg/ha	68 _{abc}	2 _c	30 _{ab}	3974
	'Aries HD' 10 kg/ha	69 _{abc}	0 _c	31 _a	4420
	'Aries HD' 15 kg/ha	78 _{abc}	5 _c	17 _{bc}	4144
	'Cannon LE'	67 _{bc}	6 _c	27 _{ab}	4425
	'Revolution'	83 _{ab}	0 _c	17 _{bc}	5370
Brome	'Bareno'	84 _a	3 _c	13 _c	3559
	'Gala'	28 _d	36 _a	36 _a	2790
Cocksfoot	'Kara'	65 _c	7 _c	29 _{ab}	4228
Tall fescue	'Advance'	65 _c	17 _b	18 _{bc}	3013
Timothy	'Viking'	77 _{abc}	5 _c	18 _{bc}	3446
	Mean	68	8	24	3940
	SEM	5.90	3.50	14.69	512
	P value	<0.001	<0.001	0.037	0.054

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

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

- The mean yield was 3.9 t DM/ha.
- 'Bareno' and 'revolution' had a higher proportion of sown grass than 'Gala', cocksfoot and tall fescue.
- Un-sown species was 36% for 'Gala' and 17% for tall fescue and averaged 3.5% for all other grasses.

Appendix 9. Harvested on 20 November 2007 (-N) regrowth period: 15/8/-20/11/2007 (97 days).

Species	Cultivar	Botanical Composition (%)			Total Yield (kg DM/ha)
		Grass	Unsown species	Dead	
Ryegrass	'Aries HD' 5 kg/ha	66 _{abc}	5 _{cd}	29 _a	1969
	'Aries HD' 10 kg/ha	67 _{abc}	0 _d	33 _a	1431
	'Aries HD' 15 kg/ha	63 _{bc}	5 _{cd}	32 _a	1325
	'Cannon LE'	70 _{abc}	4 _{cd}	26 _{ab}	1739
	'Revolution'	86 _{ab}	1 _d	13 _c	1333
Brome	'Bareno'	87 _a	4 _{cd}	9 _c	1340
	'Gala'	35 _d	33 _a	32 _a	1643
Cocksfoot	'Kara'	50 _{cd}	27 _{ab}	23 _{ab}	1593
Tall fescue	'Advance'	63 _{bc}	6 _{cd}	31 _a	1640
Timothy	'Viking'	68 _{abc}	17 _{bc}	15 _{bc}	1347
	Mean	66	10	24	1540
	SEM	8.05	15.46	4.36	689
	P value	0.005	0.001	0.002	0.589

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

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

- The mean yield was 1.5 t DM/ha.
- Without N, 'Gala' and 'Kara' cocksfoot showed the lowest sown and highest unsown (browntop) grass components.
- Total DM yield was 2.6 times higher in grasses that receive N (3.9 t DM/ha; Appendix 8) than those that did not (1.5 t DM/ha).
- Grasses that received N contained 2.7 t DM/ha of sown grass (Appendix 8) which was more than double that for grasses that did not receive N (1.0 t DM/ha, Appendix 9).
- All plots (both +N and -N) had autumn N application of 46 kg N/ha (as urea) on 19/2/2008.
- Visual symptoms of N deficiency evident to -N treatments, therefore a further 50 kg N/ha (urea) was applied on 18/3/2008 to -N treatments only.

Appendix 10. Harvested on 8 April 2008 (+N) regrowth period: 17/1/-8/4/2008 (82 days).

Species	Cultivar	Botanical Composition (%)			Total Yield (kg DM/ha)
		Grass	Unsown species	Dead	
Ryegrass	'Aries HD' 5 kg/ha	47 _{de}	28 _{abc}	25	853
	'Aries HD' 10 kg/ha	70 _{abcd}	4 _d	26	926
	'Aries HD' 15 kg/ha	53 _{cde}	16 _{abcd}	31	664
	'Cannon LE'	36 _e	36 _a	28	1084
	'Revolution'	78 _a	2 _d	20	1210
Brome	'Bareno'	68 _{abcd}	2 _d	30	571
	'Gala'	55 _{bcd}	8 _{bcd}	37	525
Cocksfoot	'Kara'	44 _e	29 _{ab}	27	827
Tall fescue	'Advance'	76 _{abc}	6 _{cd}	18	803
Timothy	'Viking'	77 _{ab}	3 _d	20	655
	Mean	61	14	26	810
	SEM	8.07	7.65	5.02	444
	P value	0.005	0.014	0.254	0.071

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

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

- The mean total yield was 810 kg DM/ha.
- Grass proportion higher in 'Revolution' (78%), than 'Cannon LE', 'Gala' and 'Kara' cocksfoot.
- High weed grass (browntop) content evident in 'Cannon LE' (36%) and 'Kara' cocksfoot plots (29%).

Individual Harvests: Year 3

Appendix 11. Harvested on 10 September 2008 rotation period: 11/4/-10/9/2008 (152 days).

Species	Cultivar	Botanical Composition (%)			Total Yield (kg DM/ha)
		Grass	Unsovn species	Dead	
Ryegrass	'Aries HD' 5 kg/ha	50 _{ab}	7	43 _{bcd}	947 _{bc}
	'Aries HD' 10 kg/ha	60 _a	4	35 _d	809 _{cd}
	'Aries HD' 15 kg/ha	55 _a	1	44 _{bcd}	787 _{cd}
	'Cannon LE'	55 _a	2	44 _{bcd}	885 _{cd}
	'Revolution'	57 _a	1	41 _{bcd}	1339 _{ab}
Brome	'Bareno'	51 _{ab}	4	46 _{bcd}	1451 _a
	'Gala'	35 _c	12	53 _{ab}	887 _{cd}
Cocksfoot	'Kara'	40 _b	1	59 _a	881 _{cd}
Tall fescue	'Advance'	46 _{ab}	1	53 _{abc}	1033 _{bc}
Timothy	'Viking'	59 _a	1	40 _{cd}	506 _d
	Mean	51	3	46	950
	SEM	4.89	3.00	4.51	139
	P value	0.016	0.014	0.033	0.003

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

Main results mid autumn – early spring:

- The mean yield was <1 t DM/ha.
- Yield was greatest from the later sown (November 2006) 'Revolution' and 'Bareno' (~1.4 t DM/ha). The lowest yield was from timothy (0.5 t DM/ha).
- Sown grass ranged from 35% ('Gala') to 60% ('Aries HD' 10 kg/ha).
- The dead material was highest over winter (46%), reflecting the lack of hard clean up grazing.

Note: Nitrogen (50 kg N/ha) was applied on the 12th of September 2008.

Appendix 12. Harvested on 21 October 2008 (+N) rotation period: 12/9/-21/10/2008 (39 days).

Species	Cultivar	Botanical Composition (%)			Total Yield (kg DM/ha)
		Grass	Unsovn species	Dead	
Ryegrass	'Aries HD' 5 kg/ha	83	7 _{bc}	10	923
	'Aries HD' 10 kg/ha	80	0 _c	20	906
	'Aries HD' 15 kg/ha	73	10 _{bc}	17	1168
	'Cannon LE'	69	17 _{ab}	15	1320
	'Revolution'	87	1 _{bc}	12	951
Brome	'Bareno'	89	1 _{bc}	10	855
	'Gala'	62	28 _a	10	811
Cocksfoot	'Kara'	82	1 _{bc}	16	852
Tall fescue	'Advance'	73	13 _{abc}	13	1248
Timothy	'Viking'	82	10 _{bc}	8	1079
	Mean	78	9	13	1011
	SEM	6.29	5.42	3.38	174
	P value	0.123	0.037	0.334	0.423

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

Main results early spring – mid spring:

- The mean yield was 1 t DM/ha over 39 days and was similar for all grasses.
- The mean component of grass was 78%.
- 'Gala' continues to show high levels of weed grass (browntop) reinvasion (28%).

Note: grazing occurred 31/10-7/11/08.

Appendix 13. Harvested on 14 January 2009 rotation length: 7/11/2008-14/1/2009 (68 days).

Species	Cultivar	Botanical Composition (%)			Total Yield (kg DM/ha)
		Grass	Unsown species	Dead	
Ryegrass	'Aries HD' 5 kg/ha	33 _{ab}	12 _{cd}	54 _{ab}	1057
	'Aries HD' 10 kg/ha	52 _a	5 _d	43 _{abc}	799
	'Aries HD' 15 kg/ha	35 _{ab}	9 _{cd}	56 _a	836
	'Cannon LE'	30 _{abc}	23 _{bcd}	47 _{abcd}	731
	'Revolution'	48 _a	0 _d	52 _{abc}	1212
Brome	'Bareno'	45 _{ab}	2 _d	53 _{abc}	1172
	'Gala'	6 _c	62 _a	32 _d	1243
Cocksfoot	'Kara'	40 _{ab}	22 _{bcd}	39 _{bcd}	1099
Tall fescue	'Advance'	21 _{bc}	42 _{ab}	37 _{cd}	1064
Timothy	'Viking'	31 _{abc}	31 _{bc}	38 _{bcd}	560
	Mean	34	21	45	977
	SEM	9.01	8.48	5.61	177
	P value	0.050	<0.001	0.047	0.140

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

Main results late spring - mid summer:

- The mean yield over summer was 980 kg DM/ha.
- Grass proportion in the 'Gala' grazing brome was low (6%) and contained the highest proportion of unsown species (62%).

Appendix 14. Harvested on 21 April 2009 rotation length: 29/1/-21/4/2009 (82 days).

Species	Cultivar	Botanical Composition (%)			Total Yield (kg DM/ha)
		Grass	Unsown species	Dead	
Ryegrass	'Aries HD' 5 kg/ha	44 _{ab}	9 _c	47	847
	'Aries HD' 10 kg/ha	50 _{ab}	17 _{bc}	33	543
	'Aries HD' 15 kg/ha	39 _{ab}	19 _{bc}	42	827
	'Cannon LE'	57 _a	4 _c	39	674
	'Revolution'	57 _a	2 _c	41	903
Brome	'Bareno'	49 _{ab}	3 _c	48	906
	'Gala'	3 _c	46 _a	51	950
Cocksfoot	'Kara'	57 _a	7 _c	35	1211
Tall fescue	'Advance'	27 _b	39 _a	34	684
Timothy	'Viking'	33 _b	35 _{ab}	32	453
	Mean	42	18	40	800
	SEM	7.69	6.37	0.125	170
	P value	<0.001	<0.001	5.05	0.149

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

Main results mid summer – mid autumn:

- Yield ranged from 453 (timothy) to 1211 kg DM/ha (cocksfoot).
- The grass component ranged from 3% ('Gala') to 57% ('Cannon' and 'Revolution').
- 'Gala' was present in trace amounts only, with 46% browntop reinvasion.

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.

Annual Yields: Year 2

Appendix 15. Annual legume, herb, unsown species and dead yields for Year 2: 1/7/2007-8/4/2008 (282 days). Harvested on: 20/11/07 and 8/4/08.

Species	Cultivar	Yield (t DM/ha)			
		Legume	Herb	Unsown species	Dead
Lucerne	'Kaituna'	0.7 _c	-	1.2 _{bc}	0.4
Red clover	'Pawera'	2.5 _a	-	0.4 _d	0.5
White clover	'Demand'	1.8 _{ab}	-	0.3 _d	0.3
Caucasian clover (Cc)	'Endura'	1.8 _{ab}	-	0.6 _{cd}	0.5
Alsike clover		1.5 _b	-	0.9 _{cd}	0.6
Subterranean	'Leura'	0.3 _c	-	1.8 _{ab}	0.5
Balansa	'Bolta'	0.5 _c	-	2.1 _a	0.4
Chicory & Cc	'Choice'	0.4 _c	0.8 _b	0.5 _{cd}	0.3
Plantain & Cc	'Tonic'	0.4 _c	1.9 _a	0.3 _d	0.5
	Mean	1.1	1.4	0.9	0.4
	SEM	0.3	0.3	0.3	0.1
	P value	<0.001	<0.001	<0.001	0.529

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

Main results:

- Annual legume yield ranged from 2.5 (red clover) to 0.4 t DM/ha (subterranean and balansa clovers).
- Plantain yield (1.9 t DM/ha) was higher than chicory (0.8 t DM/ha) and both had 0.4 t DM/ha of Caucasian clover.
- Unsown species was highest in balansa clover (2.1 t DM/ha).

Annual Yields: Year 3

Appendix 16. Annual legume, herb, unsown species and dead yields for year 3:1/7/2008-21/4/2009 (294 days). Harvested on: 21/10/08, 14/1/09 and 21/4/09.

Species	Cultivar	Yield (kg DM/ha)			
		Legume	Herb	Unsown species	Dead
Lucerne	'Kaituna'	1.4 _{cd}		0.8	0.5
Red clover	'Pawera'	2.9 _a		0.4	0.8
White clover	'Demand'	2.6 _{ab}		0.2	0.7
Caucasian clover (Cc)	'Endura'	1.7 _{bc}		0.5	0.4
Alsike clover		1.4 _{cd}		0.9	0.5
Subterranean	'Leura'	0.4 _e		1.4	0.4
Balansa	'Bolta'	1.0 _{cde}		1.6	0.5
Chicory & Cc	'Choice'	1.0 _{cde}	0.3 _b	0.7	0.4
Plantain & Cc	'Tonic'	0.8 _{de}	1.5 _a	0.5	0.5
Strawberry & subterranean	'Lucila' & 'Denmark'	0.8 _{de}		1.1	0.3
	Mean	1.4	0.9	0.8	0.5
	SEM	0.3	0.3	0.3	0.1
	P value	<0.001	0.038	0.106	0.088

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

Main results:

- Red clover had the highest annual legume yield (2.9 t DM/ha), while subterranean clover ('Leura') failed to regenerate (0.4 t DM/ha).
- Plantain annual yield (1.5 t DM/ha) was again higher than chicory (0.3 t DM/ha).
- The mean annual yield for unsown species was 0.8 t DM/ha.

Individual Harvests: Year 2

- Legume and herbs are effectively grazed close to a '0' residual and hence take longer to recover than perennial grasses and therefore there were fewer measurements in each year.

Appendix 17. Harvested on 20 November 2007 regrowth period: 30/6/-20/11/2007 (143 days).

Species	Cultivar	Botanical Composition (%)				Total Yield (kg DM/ha)
		Legume	Herb	Unsown species	Dead	
Lucerne	'Kaituna'	26 _b	-	61 _a	13	1770
Red clover	'Pawera'	76 _a	-	14 _b	11	2020
White clover	'Demand'	73 _a	-	17 _b	10	1407
Caucasian clover (Cc)	'Endura'	70 _a	-	22 _b	8	1946
Alsike clover		59 _a	-	27 _b	14	1891
Subterranean	'Leura'	20 _b	-	71 _a	9	1769
Balansa	'Bolta'	18 _b	-	78 _a	4	2199
Chicory & Cc	'Choice'	26 _b	38 _b	21 _b	15	1055
Plantain & Cc	'Tonic'	15 _b	60 _a	13 _b	12	1849
	Mean	42	49	35	10.2	1820
	SEM	8.09	4.24	8.59	3.99	349
	P value	<0.001	0.036	<0.001	0.628	0.327

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

Main results mid winter – late spring:

- The mean yield was 1.8 t DM/ha.
- The later sown Caucasian clover showed similar legume proportion (70%) to white and red clovers (75%).
- Lucerne had a low proportion of legume (26%) compared to the other perennial legumes.
- There was more plantain (60%) than chicory (38%).

Appendix 18. Harvested on 8 April 2008 regrowth period: 1/12/2007-8/4/2008 (129 days).

Species	Cultivar	Botanical Composition (%)				Total Yield (kg DM/ha)
		Legume	Herb	Unsown species	Dead	
Lucerne	'Kaituna'	58 _{ab}	-	13 _{cd}	29 _{bcd}	536 _c
Red clover	'Pawera'	68 _a	-	11 _{cd}	22 _{cde}	1302 _{ab}
White clover	'Demand'	68 _a	-	15 _{cd}	17 _{de}	978 _{bc}
Caucasian clover (Cc)	'Endura'	46 _b	-	20 _{cd}	34 _{abc}	942 _{bc}
Alsike clover		41 _b	-	32 _{cd}	28 _{bcde}	1091 _b
Subterranean	'Leura'	6 _c	-	54 _a	50 _a	811 _c
Balansa	'Bolta'	15 _c	-	45 _{ab}	40 _{ab}	908 _{bc}
Chicory & Cc	'Choice'	17 _c	40 _b	29 _{bc}	16 _{de}	981 _{bc}
Plantain & Cc	'Tonic'	7 _c	56 _a	6 _d	20 _{cde}	1348 _a
	Mean	36	60	25	28	1030
	SEM	7.61	0.696	7.97	5.32	164
	P value	<0.001	<0.001	0.003	<0.001	0.004

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

Note: chicory and plantain data is based on arcsine data.

Main results early summer – mid autumn:

- Yield ranged from 540 (lucerne) to 1350 kg DM/ha (Caucasian clover and plantain).
- Red and white clovers had higher legume (68%) content than Caucasian clover, alsike and annual clovers.
- There were large areas of bare ground in the annual clover plots and hence unsown species (sorrel) was dominant (50%) compared with other treatments.

Individual Harvests: Year 3

- Strawberry and subterranean clovers ('Denmark') were sown on 28/2/2008.

Appendix 19. Harvested on 21 October 2008 regrowth period: 10/4/2008-21/10/2008 (194 days).

Species	Cultivar	Botanical Composition (%)				Total Yield (kg DM/ha)
		Legume	Herb	Unsown species	Dead	
Lucerne	'Kaituna'	59	-	25	16	1383
Red clover	'Pawera'	64	-	15	21	2066
White clover	'Demand'	75	-	4	21	2200
Caucasian clover (Cc)	'Endura'	65	-	26	9	1521
Alsike clover		61	-	20	19	1516
Subterranean	'Leura'	28	-	58	14	1182
Balansa	'Bolta'	47	-	34	19	1929
Chicory & Cc	'Choice'	45	20 _b	28	16	1320
Plantain & Cc	'Tonic'	25	46 _a	18	11	1745
Strawberry & subterranean	'Lucila' & 'Denmark'	57	-	36	7	1168
	Mean	57	33	24	18	1630
	SEM	12.3	2.60	12.5	5.24	288
	P value	0.077	0.006	0.251	0.082	0.108

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

Note: chicory and plantain data is based on arcsine data.

Main results mid autumn – mid spring:

- The mean yield was 1.6 t DM/ha.
- Chicory is winter dormant and therefore its early spring composition (20%) was lower than plantain (45%).
- The majority of early spring production in annual legume plots was from unsown species (46%).

Appendix 20. Harvested on 14 January 2009 regrowth period: 7/11/2008-14/1/2009 (68 days).

Species	Cultivar	Botanical Composition (%)				Total Yield (kg DM/ha)
		Legume	Herb	Unsown species	Dead	
Lucerne	'Kaituna'	36 _{cd}	-	40 _{bcd}	23	942 _b
Red clover	'Pawera'	60 _a	-	9.4 _e	19	1599 _a
White clover	'Demand'	59 _{ab}	-	17 _e	16	990 _b
Caucasian clover (Cc)	'Endura'	55 _{abc}	-	15 _e	26	902 _b
Alsike clover		38 _{bcd}	-	41 _{bc}	19	1028 _b
Subterranean	'Leura'	14 _{ef}	-	55 _{ab}	19	781 _c
Balansa	'Bolta'	7.9 _f	-	62 _b	20	947 _b
Chicory & Cc	'Choice'	43 _{abcd}	19	27 _{cde}	19	830 _{bc}
Plantain & Cc	'Tonic'	36 _{cd}	37	20 _{de}	18	901 _b
Strawberry & subterranean	'Lucila' & 'Denmark'	32 _{de}	-	44 _{abc}	20	551 _c
	Mean	45	21	33	25	960
	SEM	7.49	7.30	6.78	7.60	126
	P value	<0.001	0.171	<0.001	0.462	0.001

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

Note: legume, chicory, plantain and unsown species data is based on arcsine data.

Main results late spring – mid summer:

- The tap rooted red clover total yield (1.6 t DM/ha) was double that of the annual clovers (860 kg DM/ha) which contained over 55% of unsown species.
- Lucerne was lower in yield than expected and had a higher proportion of unsown species.

Note: grazing occurred 27/1/-29/1/2009.

Appendix 21. Harvest on 21 April 2009 regrowth period: 29/1/-21/4/2009 (82 days).

Species	Cultivar	Botanical Composition (%)				Total Yield (kg DM/ha)
		Legume	Herb	Unsown species	Dead	
Lucerne	'Kaituna'	56 _{ab}	-	23 _{bcd}	16 _b	404 _{bc}
Red clover	'Pawera'	65 _a	-	15 _{cd}	10 _b	406 _{bc}
White clover	'Demand'	61 _a	-	15 _{cd}	13 _b	326 _{bc}
Caucasian clover (Cc)	'Endura'	58 _{ab}	-	11 _d	22 _{ab}	307 _{bc}
Alsike clover		36 _{bcd}	-	35 _{bc}	20 _b	263 _{bc}
Subterranean	'Leura'	31 _{cde}	-	44 _{ab}	22 _a	185 _c
Balansa	'Bolta'	10 _e	-	65 _a	16 _b	282 _{bc}
Chicory & Cc	'Choice'	35 _{bcd}	3 _b	36 _{bc}	23 _{ab}	290 _{bc}
Plantain & Cc	'Tonic'	20 _{de}	59 _a	17 _{cd}	19 _b	939 _a
Strawberry & subterranean	'Lucila' & 'Denmark'	46 _{abc}	-	36 _{bc}	13 _{ab}	493 _b
	Mean	50	31	30	20	390
	SEM	8.40	7.64	8.34	4.73	231
	P value	<0.001	0.013	<0.001	0.044	<0.001

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

Note: legume and unsown species data is based on arcsine data.

Main results mid summer – late autumn:

- Total yield ranged from 185 (subterranean clover) to 940 kg DM/ha (plantain and Caucasian clover).
- White, Caucasian and red clovers contained a high proportion (~60%) of legume 2/3 years after sowing.
- Balansa clover only contributed 10% of its total yield (280 kg DM/ha) and had the highest proportion of unsown species (65%).

Pasture Mixtures

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 in 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/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 Yields: Year 2

Appendix 22 Annual grass, clovers, unsown species and dead yields for year 2: 6/9/2007-8/4/2008 (215 days). Harvested on: 20/11/07 and 8/4/08.

Cultivar and rate	Yield (t DM/ha)					
	Ryegrass	Cocksfoot	White clover	Sub. clover	Unsown species	Dead
‘Revolution’ AR1 10 kg/ha	1.3 _b	-	1.9	0.2	0.0	0.4
‘Revolution’ AR1 20 kg/ha	2.8 _a	-	1.5	0.3	0.0	0.3
‘Revolution’ AR1 10 kg/ha & ‘Dg25’ Cocksfoot	1.5 _b	0.1 _b	1.6	0.2	0.0	0.3
‘Cannon’ HE 10 kg/ha	2.0 _{ab}	-	1.5	0.4	0.0	0.3
‘Samson’ AR1 10 kg/ha	1.7 _b	-	1.6	0.6	0.0	0.3
Mean	1.9		1.6	0.3	0.0	0.3
SEM	0.3		0.4	0.9	0.0	1.0
P value	0.030		0.949	0.089	0.256	0.885

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

Main results:

- Grass yield ranged from 1.3 (‘Revolution’ 10 kg/ha) to 2.8 t DM/ha (‘Revolution’ 20 kg/ha).
- The mean yield for white clover was 1.6 t DM/ha and 0.3 t DM/ha for subterranean clover.

Annual Yields: Year 3

Appendix 23 Annual grass, clovers, unsown species and dead yields for year 3: 3/7/2008-30/4/2009 (301 days). Harvested on: 10/9/08, 21/10/08, 22/1/09 and 30/4/09.

Cultivar	Yield (t DM/ha)					
	Ryegrass	Cocksfoot	White clover	Sub. clover	Unsown species	Dead
'Revolution' AR1 10 kg/ha	2.5	-	0.9	0.0	0.0	1.1
'Revolution' AR1 20 kg/ha	2.7	-	0.8	0.0	0.0	1.1
'Revolution' AR1 10 kg/ha & 'Dg25' Cocksfoot	1.8	1.0	0.6	0.0	0.0	1.2
'Cannon' HE 10 kg/ha	1.9	-	1.0	0.0	0.0	1.0
'Samson' AR1 10 kg/ha	2.2	-	0.7	0.0	0.0	0.9
Mean	2.4		0.8	0.0	0.0	1.2
SEM	0.2		0.1	0.0	0.0	0.2
P value	0.084		0.243	0.361	0.717	0.7

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

Main results:

- The mean annual yield for grass was 2.4 t DM/ha and 0.8 t DM/ha for white clover.
- 'Leura' subterranean clover failed to regenerate in Year 2.

Individual Harvests: Year 1

Appendix 24. Harvested on 18 July 2007 rotation period: 30/1/-18/7/2007 (169 days).

Cultivar	Botanical Composition (%)						Total Yield (kg DM/ha)
	Ryegrass	Cocksfoot	White clover	Sub. clover	Unsown species	Dead	
'Revolution' AR1 10 kg/ha	58	-	2	10	0	30	842
'Revolution' AR1 20 kg/ha	51	-	2	8	0	39	857
'Revolution' AR1 10 kg/ha & 'Dg25' Cocksfoot	41	1	6	12	2	38	847
'Cannon' HE 10 kg/ha	45	-	2	17	0	36	612
'Samson' AR1 10 kg/ha	39	-	3	12	0	46	818
Mean	47*		3	12	0	38	800
SEM	4.10		1.42	3.37	0.72	4.51	128
P value	0.08		0.427	0.483	0.514	0.250	0.640

* = mean for all sown grasses.

Main results sowing to mid winter:

- Mid winter there was little growth (800 kg DM/ha).
- Cocksfoot only contributed 8 kg DM/ha.
- The mean yield for white clover was 24 kg DM/ha and 96 kg DM/ha for subterranean clover.
- The high dead material represented ungrazed pasture from the previous autumn.

Individual Harvests: Year 2

Appendix 25. Harvested on 5 November 2007 rotation period: 20/8/-5/11/2007 (77 days).

Cultivar	Botanical Composition (%)						Standing Yield (kg DM/ha)
	Ryegrass	Cocksfoot	White clover	Sub. clover	Unsown species	Dead	
'Revolution' AR1 10 kg/ha	36	-	51	7	0	6	1792
'Revolution' AR1 20 kg/ha	41	-	45	6	0	8	1640
'Revolution' AR1 10 kg/ha & 'Dg25' Cocksfoot	37	4	41	9	0	9	1329
'Cannon' HE 10 kg/ha	35	-	45	12	0	8	1737
'Samson' AR1 10 kg/ha	30	-	39	25	0	6	1407
Mean	37*		44	12	0	7	1580
SEM	6.55		8.3	5.80	0.08	1.75	158
P value	0.748		0.835	0.217	0.461	0.636	0.250

* = mean for all sown grasses.

Main results late winter - late spring:

- The mean yield was 1580 kg DM/ha.
- The pasture was split between white clover (44%), and 37% grasses with about 12% of subterranean clover.

Appendix 26 Harvested on 20 November 2007 rotation period: 20/8/-20/11/2007 (92 days).

Cultivar	Botanical Composition (%)						Total Yield (kg DM/ha)
	Ryegrass	Cocksfoot	White clover	Sub. clover	Unsown species	Dead	
'Revolution' AR1 10 kg/ha	22	-	56	9	0	13	2958
'Revolution' AR1 20 kg/ha	49	-	30	11	0	10	3337
'Revolution' AR1 10 kg/ha & 'Dg25' Cocksfoot	28	3	47	9	0	13	2491
'Cannon' HE 10 kg/ha	38	-	34	19	0	8	3096
'Samson' AR1 10 kg/ha	36	-	37	19	0	8	3179
Mean	35*		41	13	0	10	3010
SEM	6.60		6.29	4.97	0	2.33	484
P value	0.145		0.105	0.441	0	0.334	0.776

* = mean for all sown grass.

Main results late winter – end of spring:

- Mean total yield was about 3 t DM/ha for all treatments with 35% grass, 40% white clover and 15% subterranean clover.
- The mean yield for white clover was 1230 kg DM/ha compared to subterranean clover with 390 kg DM/ha.
- Rapid establishment of perennial ryegrass means there was no weed invasion in the first spring.
- The mean daily growth rate of the ryegrass mixtures was 33 kg DM/ha/day.

Appendix 27. Harvested on 8 April 2008 rotation period: 17/1/-8/4/2008 (82 days).

Cultivar	Botanical Composition (%)						Total Yield (kg DM/ha)
	Ryegrass	Cocksfoot	White clover	Sub. clover	Unsown species	Dead	
'Revolution' AR1 10 kg/ha	59	-	19	0	0	22	1187 _b
'Revolution' AR1 20 kg/ha	52	-	20	0	0	28	2126 _a
'Revolution' AR1 10 kg/ha & 'Dg25' Cocksfoot	55	7	17	0	1	19	1571 _b
'Cannon' HE 10 kg/ha	51	-	25	0	0	24	1534 _b
'Samson' AR1 10 kg/ha	45	-	29	0	1	25	1295 _b
Mean	54*		22	0	0	24	1540
SEM	6.35		5.34	0.03	0.48	4.00	136
P value	0.387		0.564	0.461	0.188	0.618	0.009

* = mean for all sown grasses. Treatment means followed by the same letter subscript are not significantly different.

Main results mid summer – mid autumn:

- 'Revolution' (20 kg/ha) had a higher yield (2.1 t DM/ha) than other treatments (1.4 t DM/ha).
- Total grass was 62% for 'Revolution' plus 'Dg25' cocksfoot mix (62%), compared with other treatments at 52% for the ryegrasses alone.
- The mean yield for white clover was 339 kg DM/ha but the 'Leura' subterranean clover failed to re establish.

Appendix 28. Harvested on 2 July 2008 rotation period: 12/4/-2/7/2008 (81 days).

Cultivar	Botanical Composition (%)						Standing Yield (kg DM/ha)
	Ryegrass	Cocksfoot	White clover	Sub. clover	Unsown species	Dead	
'Revolution' AR1 10 kg/ha	64 _b	-	2	0	0	34 _{abc}	673
'Revolution' AR1 20 kg/ha	73 _a	-	2	0	0	25 _c	662
'Revolution' AR1 10 kg/ha & 'Dg25' Cocksfoot	50 _c	9 _c	3	0	0	38 _{ab}	438
'Cannon' HE 10 kg/ha	66 _{ab}	-	2	0	0	32 _{bc}	405
'Samson' AR1 10 kg/ha	55 _c	-	2	0	0	43 _a	646
Mean	63*		2	0	0	34	570
SEM	2.66		0.84	0.08	0.16	2.72	112
P value	0.012		0.691	0.136	0.547	0.021	0.321

* = mean for all sown grasses. Treatment means followed by the same letter subscript are not significantly different.

Main results mid autumn – mid winter:

- The mean yield was 570 kg DM/ha.
- 'Revolution' (20 kg/ha) had the highest proportion of grass (73%) and lowest dead content (25%).
- White clover produced 11 kg DM/ha over winter (2% of composition).
- There was a higher proportion of grass (63%) than measured the previous year (47% Appendix 24).

Individual Harvests: Year 3

Appendix 29. Harvested on 28 July 2008 rotation period: 12/4/-28/7/2008 (107 days).

Cultivar	Botanical Composition (%)						Standing yield (kg DM/ha)
	Ryegrass	Cocksfoot	White clover	Sub. clover	Unsown species	Dead	
'Revolution' AR1 10 kg/ha	51	-	5	0	0	44	690
'Revolution' AR1 20 kg/ha	57	-	1	0	0	42	765
'Revolution' AR1 10 kg/ha & 'Dg25' Cocksfoot	59	2	2	0	0	37	496
'Cannon' HE 10 kg/ha	46	-	1	0	0	53	580
'Samson' AR1 10 kg/ha	59	-	2	0	0	39	499
Mean	55*		2	0	0	43	610
SEM	4.90		1.80	0	0	4.58	107
P value	0.292		0.507	0	0	0.260	0.367

* = mean for all sown grasses.

Main results mid autumn – mid winter:

- Mid winter yield was 610 kg DM/ha.
- The mean for grass was 55%, 2% for white clover and 43% dead.

Appendix 30. Harvested on 10 September 2008 rotation period: 12/4/-10/9/2008 151 days.

Cultivar	Botanical Composition (%)						Total Yield (kg DM/ha)
	Ryegrass	Cocksfoot	White clover	Sub. clover	Unsown species	Dead	
'Revolution' AR1 10 kg/ha	70	-	5	0	0	25	647
'Revolution' AR1 20 kg/ha	80	-	2	0	0	18	867
'Revolution' AR1 10 kg/ha & 'Dg25' Cocksfoot	61	8	6	0	0	25	750
'Cannon' HE 10 kg/ha	72	-	7	0	0	20	654
'Samson' AR1 10 kg/ha	89	-	6	0	0	5	670
Mean	76*		5	0	0	19	720
SEM	4.97		2.73	0	0	5.93	126
P value	0.102		0.721	0	0	0.21	0.71

* = mean for all sown grasses.

Main results mid autumn – early spring:

- Start of spring gave only a small increase in yield (720 kg DM/ha) from the end of July (610 kg DM/ha (Appendix 29)). This was a mean daily growth rate of 2.5 kg DM/ha/day.
- The mean grass yield was 550 kg DM/ha compared with 36 kg DM/ha for white clover and no subterranean clover was found.
- The soil temperatures (to 10 cm depth) follow a similar pattern to the previous year (8.2 and 8.6°C in September 2007 and 2008, respectively). In both years rapid spring growth did not occur until October when soil temperatures were above 10 °C.

Appendix 31. Harvested on 21 October 2008 rotation period: 12/9/-21/10/2008 (39 days).

Cultivar	Botanical Composition (%)						Total Yield (kg DM/ha)
	Ryegrass	Cocksfoot	White clover	Sub. clover	Unsown species	Dead	
'Revolution' AR1 10 kg/ha	44	-	42	0	0	14	1819
'Revolution' AR1 20 kg/ha	45	-	35	0	0	20	1947
'Revolution' AR1 10 kg/ha & 'Dg25' Cocksfoot	44	14	24	0	0	18	1600
'Cannon' HE 10 kg/ha	41	-	42	0	0	17	1854
'Samson' AR1 10 kg/ha	49	-	36	0	0	15	1521
Mean		48*	36	0	0	17	1750
SEM		7.01	5.32	0	0	3.16	245
P value		0.463	5.32	0	0	0.647	0.713

* = mean for all sown grasses.

Main results early spring – mid spring:

- The mean yield was 1750 kg DM/ha for all treatments.
- White clover again dominated spring clover component (36%). Lack of subterranean clover (0%) was similar to that found in the legume monocultures.
- Mean daily growth rate increased to 45 kg DM/ha which would support lambing on 7/10/2008.

Appendix 32. Harvested on 22 January 2009 rotation period: 21/10/2008-22/1/2009 (93 days).

Cultivar	Botanical Composition (%)						Total Yield (kg DM/ha)
	Ryegrass	Cocksfoot	White clover	Sub. clover	Unsown species	Dead	
'Revolution' AR1 10 kg/ha	41	-	12	0	0	47	766
'Revolution' AR1 20 kg/ha	55	-	7	0	0	38	865
'Revolution' AR1 10 kg/ha & 'Dg25' Cocksfoot	20	21	5	0	0	54	1240
'Cannon' HE 10 kg/ha	32	-	24	0	2	42	595
'Samson' AR1 10 kg/ha	33	-	10	0	0	57	673
Mean		41*	12	0	0	47	830
SEM		8.25	4.94	0	0.95	9.65	183
P value		0.226	0.146	0	0.461	0.476	0.203

* = mean for all sown grasses.

Main results mid spring – mid summer:

- The mean yield was 830 kg DM/ha
- 'Revolution' with 'Dg25' cocksfoot yield was 1240 kg DM/ha compared with 766 kg DM/ha for 'Revolution' sown as the sole grass. This shows that cocksfoot mixed with ryegrass sown at 10 kg/ha spreads feed supply over summer when ryegrass growth was low.
- White clover was 12% of the total pasture composition but no subterranean clover was found.

Appendix 33. Harvested on 19 March 2009 rotation period: 29/1/-19/3/2009 (49 days).

Cultivar	Botanical Composition (%)						Standing Yield (kg DM/ha)
	Ryegrass	Cocksfoot	White clover	Sub. clover	Unsown species	Dead	
'Revolution' AR1 10 kg/ha	76	-	3	0	1	20	852
'Revolution' AR1 20 kg/ha	80	-	5	0	0	15	562
'Revolution' AR1 10 kg/ha & 'Dg25' Cocksfoot	27	55	1	0	0	17	649
'Cannon' HE 10 kg/ha	75	-	3	0	0	22	607
'Samson' AR1 10 kg/ha	75	-	6	0	0	19	590
Mean	77*		3	0	0	19	650
SEM	5.17		1.06	0	0.31	5.08	77.3
P value	0.801		0.08	0	0.821	0.871	0.152

* = mean for all sown grasses.

Main results mid summer – early autumn:

- The mean yield was 650 kg DM/ha.
- March shows the peak of cocksfoot production at 55% of the total. In contrast, the 'Revolution' component was only 27% and 77% for the other ryegrasses.
- White clover was only 20 kg DM/ha.
- The 2008/09 growth season was shortened by early onset of drought, late rain in December proved insufficient to carry production into mid summer or autumn.

Appendix 34. Harvested on 30 April 2009 rotation period: 29/1/-30/4/2009 (91 days).

Cultivar	Botanical Composition (%)						Total Yield (kg DM/ha)
	Ryegrass	Cocksfoot	White clover	Sub. clover	Unsown species	Dead	
'Revolution' AR1 10 kg/ha	71 _a	-	3	0	1	25 _a	1233
'Revolution' AR1 20 kg/ha	72 _a	-	2	0	1	25 _b	980
'Revolution' AR1 10 kg/ha & 'Dg25' Cocksfoot	36 _a	39 _a	4	0	0	21 _a	1028
'Cannon' HE 10 kg/ha	59 _b	-	3	0	1	37 _a	846
'Samson' AR1 10 kg/ha	70 _a	-	2	0	0	28 _a	862
Mean	69*		3	0	1	28	990
SEM	2.19		1.15	0	0.68	1.92	232
P value	0.01		0.436	0	0.742	0.005	0.768

* = mean for all sown grasses. Treatment means followed by the same letter subscript are not significantly different.

Main results mid summer – mid autumn:

- Yield over autumn was 990 kg DM/ha.
- The grass component in 'Cannon' was lower than other treatments and evenly split between ryegrass and cocksfoot when both were sown.
- White clover yield was 30 kg DM/ha (3%).
- Growth at Lees Valley for ryegrass based pastures was constrained by cold winters (120 days+) and drought conditions occurring from December to March. The main growth period was October and November, which matches lambing date.

Dryland 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/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 Yields: Year 2

Appendix 35. Annual grass, clovers, unsown species and dead yields for year 2: 6/9/2007-8/4/2008 (215 days). Harvested on: 20/11/07 and 8/4/08.

Cultivar/Species	Yield (t DM/ha)				
	Grass	White clover	Sub. clover	Unsown species	Dead
'Advance' Tall fescue	0.6	2.6	0.4	0.0	0.9
'Advance' Tf +endophyte	1.3	1.8	0.7	0.1	0.8
Agriseeds 'Dg25' Cf	1.4	1.4	0.3	0.0	0.7
'Ella' cocksfoot	1.1	2.4	0.2	0.0	1.1
'Bareno' brome	1.6	1.7	0.2	0.0	0.7
Mean	1.2	2.0	0.3	0	0.8
SEM	0.3	0.4	0.1	0	0.1
P value	0.268	0.319	0.068	0.516	0.135

Note: Cf = cocksfoot, Tf = tall fescue

Main results:

- The mean grass yield was 1.2 t DM/ha with 2.0 t DM/ha of white clover.
- The mean yield of subterranean clover was 0.3 t DM/ha.

Annual Yields: Year 3

**Appendix 36. Annual grass, clovers, unsown species and dead yields for year 3:
3/7/2008-30/4/2009 (301 days). Harvested on: 10/9/08, 21/10/08, 22/1/09 and 30/4/09.**

Cultivar/Species	Yield (t DM/ha)				
	Grass	White clover	Sub. clover	Unsown species	Dead
'Advance' Tall fescue	0.6 _c	1.5	0.0	0.1	0.4 _c
'Advance' Tf +endophyte	1.0 _c	1.2	0.0	0.1	0.5 _c
Agriseeds 'Dg25' Cf	3.3 _a	0.8	0.0	0.0	2.3 _a
'Ella' cocksfoot	2.5 _b	1.1	0.0	0.1	1.5 _b
'Bareno' brome	2.7 _b	0.7	0.0	0.0	2.1 _{ab}
Mean	2.0	1.1	0	0.1	1.4
SEM	0.2	0.2	0	0	0.2
P value	<0.001	0.215	0.350	0.194	<0.001

Note: Cf = cocksfoot, Tf = tall fescue

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

Main results:

- The grass yield ranged from ~0.8 (tall fescue) to 3.3 t DM/ha ('Dg25' cocksfoot).
- The mean yield for white clover was 1.1 t DM/ha.
- 'Leura' subterranean clover failed to regenerate.
- Grass yield increased from 1.2 t DM/ha in Year 2 (Appendix 35) to 2.0 t DM/ha (Appendix 36) in Year 3.
- The ryegrass based pastures yielded 2.4 t DM/ha (Appendix 23) compared with 2.0 t DM/ha for dryland mixtures.

Individual Harvests: Year 1

Appendix 37. Harvested on 18 July 2007 rotation period: 18/7/-30/1/2007 (169 days).

Cultivar/Species	Botanical Composition (%)					Total Yield (kg DM/ha)
	Grass	White clover	Sub. clover	Unsown species	Dead	
'Advance' Tall fescue	6 _b	16	54	0	24	794
'Advance' Tf +endophyte	16 _b	14	46	0	24	730
Agriseeds 'Dg25' Cf	23 _b	9	43	4	21	634
'Ella' cocksfoot	15 _b	13	44	4	24	653
'Bareno' brome	61 _a	4	16	0	19	781
Mean	24	11	41	2	23	720
SEM	6.09	2.92	8.84	6.38	3.49	103
P value	0.002	0.125	0.117	0.442	0.805	0.736

Note: Cf = cocksfoot, Tf = tall fescue

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

Main results sowing to mid winter:

- The mean yield was 720 kg DM/ha.
- 'Bareno' brome established earlier than tall fescue and cocksfoot and therefore had a higher grass proportion (61% vs. 15%).
- The subterranean clover (41%) component was higher in the dryland mixtures compared to the ryegrass mixtures (12%) for the same period (Appendix 24).
- The slower emergence of the dryland grasses has meant less competition and more bare ground and therefore a higher amount of sown clover (52%) compared with the ryegrass mixtures (15 %, Appendix 24).
- Total yield was similar to ryegrass mixtures (800 kg DM/ha, Appendix 17) for the same period, however clover contributed 373 kg DM/ha in dryland mixtures compared to 113 kg DM/ha in ryegrass mixtures.

Individual Harvests: Year 2

Appendix 38. Harvested on 5 November 2007 rotation period: 20/8/-5/11/2007 (77 days).

Cultivar/Species	Botanical Composition (%)					Standing Yield (kg DM/ha)
	Grass	White clover	Sub. clover	Unsown species	Dead	
'Advance' Tall fescue	11	65	15	0	9	2047
'Advance' Tf +endophyte	17	57	17	1	8	2027
Agriseeds 'Dg25' Cf	8	62	17	1	11	1556
'Ella' cocksfoot	7	75	9	1	7	1812
'Bareno' brome	23	52	9	1	15	1814
Mean	13	63	13	1	11	1850
SEM	3.90	4.96	3.61	0.35	2.69	278
P value	0.101	0.079	0.394	0.458	0.368	0.726

Note: Cf = cocksfoot, Tf = tall fescue

Main results early spring – late spring:

- The mean yield was 1850 kg DM/ha.
- The mean grass and subterranean contributions to total yield were 13% with 63% of white clover.

Appendix 39. Harvested on 20 November 2007 rotation period: 20/8/-20/11/2007 (92 days).

Cultivar/Species	Botanical Composition (%)					Total Yield (kg DM/ha)
	Grass	White clover	Sub. clover	Unsown species	Dead	
'Advance' Tall fescue	4	64	13	0	19	2950
'Advance' Tf +endophyte	17	39	23	2	19	2880
Agriseeds 'Dg25' Cf	17	52	14	0	17	2111
'Ella' cocksfoot	8	59	6	1	26	2991
'Bareno' brome	22	54	7	1	16	2683
Mean	14	54	13	1	19	2720
SEM	3.94	8.14	4.52	1.03	4.09	273
P value	0.065	0.337	0.167	0.034	0.604	0.229

Note: Cf = cocksfoot, Tf = tall fescue

Main results early spring – end of spring:

- In the first spring (2007) all dryland pastures produced ~2.7 t DM/ha.
- Grass proportion ranged from 4 (tall fescue) to 22% ('Bareno' brome).
- White clover was dominant at 54% compared with 13% for subterranean clover.
- Weed invasion was negligible (1%).
- The mean growth rate of the dryland mixture was 30 kg DM/ha/day.

Appendix 40. Harvested on 8 April 2008 rotation period: 17/1/-8/4/2008 (82 days).

Cultivar/Species	Botanical Composition (%)					Total Yield (kg DM/ha)
	Grass	White clover	Sub. clover	Unsown species	Dead	
'Advance' Tall fescue	33 _b	47	0	0	20	1536
'Advance' Tf +endophyte	48 _{ab}	33	0	0	18	1731
Agriseeds 'Dg25' Cf	65 _a	16	0	0	19	1612
'Ella' cocksfoot	45 _{ab}	35	0	0	20	1846
'Bareno' brome	66 _a	13	0	1	20	1523
Mean	52	29	0	0	19	1650
SEM	6.69	67.4	0	0.32	4.92	422.5
P value	0.035	0.057	0.461	0.510	0.998	0.997

Note: Cf = cocksfoot, Tf = tall fescue

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

Main results mid summer – mid autumn:

- Total yield of dryland pastures (1.6 t DM/ha) was similar to that from the ryegrass pastures (1.5 t DM/ha) (Appendix 27).
- 'Dg25' cocksfoot and 'Bareno' brome had ~66% grass
- By mid autumn 2008 white clover contributed only 29% to the dryland pasture with 52% grass. This contrasts to spring 2007 when white clover was dominant (Appendix 39).

Appendix 41. Harvested on 2 July 2008 rotation period: 12/4/-2/7/2008 (81 days).

Cultivar/Species	Botanical Composition (%)					Standing Yield (kg DM/ha)
	Grass	White clover	Sub. clover	Unsown species	Dead	
'Advance' Tall fescue	38	17	0	7	38	173 _b
'Advance' Tf +endophyte	64	11	0	0	24	241 _b
Agriseeds 'Dg25' Cf	68	1	0	0	31	589 _b
'Ella' cocksfoot	59	7	0	0	34	481 _b
'Bareno' brome	59	8	0	0	33	1444 _a
Mean	58	9	0	2	32	590
SEM	8.88	3.86	0	3.31	3.9	133
P value	0.231	0.126	0.608	0.465	0.269	<0.001

Note: Cf = cocksfoot, Tf = tall fescue

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

Main results mid autumn – mid winter:

- 'Bareno' brome had a higher yield over winter (1440 kg DM/ha) than all other grasses.
- The mean grass contribution to total yield was 58% with 9% white clover and no subterranean clover regenerated.
- The mean yield for white clover was 53 kg DM/ha.

Individual Harvests: Year 3**Appendix 42. Harvested on 18 July 2008 rotation period: 12/4/-28/7/2008 (107 days).**

Cultivar/Species	Botanical Composition (%)					Standing Yield (kg DM/ha)
	Grass	White clover	Sub. clover	Unsown species	Dead	
'Advance' Tall fescue	57	9	0	2	32	92 _b
'Advance' Tf +endophyte	67	7	0	0	26	194 _b
Agriseeds 'Dg25' Cf	59	5	0	0	35	733 _{ab}
'Ella' cocksfoot	50	5	0	0	44	835 _{ab}
'Bareno' brome	66	4	0	0	30	1221 _a
Mean	60	6	0	0	34	615
SEM	7.61	3.74	0	0.93	5.35	235
P value	0.558	0.918	0.461	0.486	0.246	0.046

Note: Cf = cocksfoot, Tf = tall fescue

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

Main results mid autumn – mid winter:

- 'Bareno' had a higher yield 1220 kg DM/ha than tall fescue.
- The grass component contributed about 60% of total yield with only 6% white clover.
- The dead material represents ungrazed herbage from previous rotations.

Appendix 43. Harvested on 10 September 2008 rotation period: 12/4/-10/9/2008 (151 days).

Cultivar/Species	Botanical Composition (%)					Total Yield (kg DM/ha)
	Grass	White clover	Sub. clover	Unsown species	Dead	
'Advance' Tall fescue	27 _b	54 _a	0	0	18	406 _b
'Advance' Tf +endophyte	63 _a	13 _b	0	0	24	615 _b
Agriseeds 'Dg25' Cf	56 _a	6 _b	0	0	38	1415 _a
'Ella' cocksfoot	50 _a	26 _{ab}	0	0	25	609 _b
'Bareno' brome	55 _a	19 _b	0	0	26	1682 _a
Mean	50	24	0	0	26	945
SEM	4.96	9.46	0	0	6.12	198
P value	0.008	0.048	0	0	0.305	0.006

Note: Cf = cocksfoot, Tf = tall fescue

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

Main results mid autumn – start of spring:

- Total yield was higher for 'Dg25' cocksfoot and 'Bareno' (1500 kg DM/ha) than other grasses.
- Tall fescue had the least amount of grass (27%) but highest white clover content (54%).
- 'Leura' subterranean clover failed to regenerate.

Appendix 44. Harvested on 21 October 2008 rotation period: 12/9/-21/10/2008 (39 days).

Cultivar/Species	Botanical Composition (%)					Total Yield (kg DM/ha)
	Grass	White clover	Sub. clover	Unsown species	Dead	
'Advance' Tall fescue	15 _b	69 _a	0	3	13 _c	1421
'Advance' Tf +endophyte	22 _b	58 _{ab}	1	2	17 _{bc}	1276
Agriseeds 'Dg25' Cf	26 _b	35 _{bc}	0	1	38 _a	1709
'Ella' cocksfoot	24 _b	52 _{ab}	0	0	23 _{bc}	1741
'Bareno' brome	45 _a	24 _c	0	1	30 _{ab}	1590
Mean	27	48	0	1	24	1550
SEM	5.19	8.45	0.60	1.17	4.25	227
P value	0.034	0.032	0.553	0.787	0.021	0.583

Note: Cf = cocksfoot, Tf = tall fescue

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

Main results start of spring – mid spring:

- Total yield averaged 1550 kg DM/ha.
- 'Bareno' had double the grass content of other species but less clover (24%).
- Treatments were mown on 12/9/2008. Reducing grass at this stage has allowed white clover to dominate (48%).
- The growth rate averaged 40 kg DM/ha/day for 39 days.

Appendix 45. Harvested on 22 January 2009 rotation period: 21/10/2008-22/1/2009 (93 days).

Cultivar/Species	Botanical Composition (%)					Total Yield (kg DM/ha)
	Grass	White clover	Sub. clover	Unsown species	Dead	
'Advance' Tall fescue	24 _b	53 _a	0	5	18 _c	540 _{bc}
'Advance' Tf +endophyte	42 _{ab}	39 _a	0	0	18 _c	377 _c
Agriseeds 'Dg25' Cf	54 _a	3 _b	0	0	43 _{ab}	1721 _a
'Ella' cocksfoot	56 _a	5 _b	0	5	35 _{bc}	1703 _a
'Bareno' brome	39 _{ab}	2 _b	0	0	58 _a	1369 _{ab}
Mean	43	20	0	2	35	1140
SEM	5.87	5.66	0	2.75	5.81	295
P value	0.029	<0.001	0	0.476	0.005	0.029

Note: Cf = cocksfoot, Tf = tall fescue

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

Main results mid spring – mid summer:

- Both cocksfoot treatments had higher total yield (1710 kg DM/ha) than tall fescue.
- Both tall fescue treatments had ten times more white clover (46%), than other grasses.

Appendix 46. Harvested on 19 March 2009 rotation period: 29/1/-19/3/2009 (49 days).

Cultivar/Species	Botanical Composition (%)					Standing Yield (kg DM/ha)
	Grass	White clover	Sub. clover	Unsown species	Dead	
'Advance' Tall fescue	68	15 _{ab}	0	7	10 _b	387 _c
'Advance' Tf +endophyte	69	19 _a	0	7	5 _b	394 _c
Agriseeds 'Dg25' Cf	87	0 _c	0	1	11 _b	1478 _a
'Ella' cocksfoot	83	3 _{bc}	0	1	13 _{ab}	914 _b
'Bareno' brome	78	2 _{bc}	0	0	20 _a	896 _b
Mean	77	8	0	3	12	810
SEM	14.96	4.11	0.10	3.27	2.49	129
P value	0.066	0.039	0.558	0.463	0.029	0.002

Note: Cf = cocksfoot, Tf = tall fescue

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

Main results mid summer – early autumn:

- The yield ranged from 390 (tall fescue) to 1480 kg DM/ha ('Dg25' cocksfoot).
- On average grass contributed 77% of total DM produced, with more white clover (~17%) in tall fescue than other grasses.

Appendix 47. Harvested on 30 April 2009 rotation period: 29/1/-30/4/2009 (91 days).

Cultivar/Species	Botanical Composition (%)					Total Yield (kg DM/ha)
	Grass	White clover	Sub. clover	Unsown species	Dead	
'Advance' Tall fescue	37	32 _a	0 _b	12	19	227 _c
'Advance' Tf +endophyte	41	36 _a	1 _a	6	16	489 _c
Agriseeds 'Dg25' Cf	74	0 _b	0 _b	0	26	1512 _a
'Ella' cocksfoot	72	1 _b	0 _b	1	27	1163 _b
'Bareno' brome	60	3 _b	0 _b	3	34	962 _b
Mean	57	14	0	4	24	870
SEM	10.41	6.45	0.12	4.08	5.55	96.0
P value	0.103	0.007	0.003	0.282	0.249	<0.001

Note: Cf = cocksfoot, Tf = tall fescue

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

Main results mid summer – mid autumn:

- The total yield was highest for 'Dg25' cocksfoot (1510 kg DM/ha) and lowest from tall fescue pastures.
- The mean proportion of sown grass was 57%.
- Tall fescue had a higher proportion of white clover (32%) than other grasses due to the low total yield.

Timothy 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 2008.
- Maintenance fertiliser (superphosphate) applied October 2007 (750 kg/ha) and September 2008 (300 kg/ha). February 2008 urea applied at 100 kg/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 Yields: Year 2

Appendix 48. Annual timothy, clovers, herbs, unsown species and dead yield for year 2: 6/9/2007-8/4/2008 (215 days). Harvested on: 20/11/07 and 8/4/08.

	Yield (t DM/ha)							
	Tim	White clover	Sub. clover	Chicory	Plantain	Red clover	Unsown species	Dead
'Kahu' timothy	0.2	2.3	0.5	-	-	-	0.0	0.5
'Kahu' timothy & chicory	0.3	2.1	0.2	0.6	-	-	0.0	0.5
'Kahu' timothy & plantain	0.3	1.6	0.4	-	1.0	-	0.0	0.3
'Kahu' timothy & chicory/plantain	0.2	1.8	0.3	0.1	0.7	-	0.0	0.4
'Kahu' timothy & red clover	0.3	1.2	0.3	-	-	0.6	0.0	0.3
Mean	0.3	1.8	0.3	0.4*	0.8*		0.0	0.4
SEM	0.1	0.5	0.1	0.1	0.8	N/A	0.0	0.1
P value	0.938	0.537	0.343	0.108	0.425		0.509	0.313

Note: N/A = not applicable as there is only one treatment. * = means from two treatments. - = not sown

Main results:

- Mean yield for timothy was 0.3 t DM/ha, with 1.8 t DM/ha of white clover, 0.3 t DM/ha of subterranean clover and 0.6 t DM/ha of red clover.

Annual Yields: Year 3

Appendix 49. Annual timothy, clovers, herbs, unsown species and dead yield for year 3: 1/7/2008-30/4/2009 (303 days). Harvested on: 21/10/08, 22/1/09 and 30/4/09.

	Yield (%)							
	Tim	White clover	Sub. clover	Chicory	Plantain	Red clover	Unsown species	Dead
'Kahu' timothy	0.2	1.4 _a	0.0	-	-	-	0.2	0.3
'Kahu' timothy & chicory	0.6	0.9 _b	0.0	0.2	-	-	0.0	0.5
'Kahu' timothy & plantain	0.1	0.8 _b	0.0	-	1.8	-	0.1	0.5
'Kahu' timothy & chicory/plantain	0.5	0.7 _b	0.0	0.1	1.5	-	0.0	0.5
'Kahu' timothy & red clover	0.4	1.1 _{ab}	0.0	-	-	0.2	0.1	0.4
Mean	0.4	1.0	0	0.2	1.7		0.1	0.5
SEM	0.2	0.1	0	0	0.1	N/A	0.1	0.5
P value	0.368	0.047	0.772	0.153	0.168		0.125	0.562

Note: N/A = not applicable as there is only one treatment. * = means from two treatments. - = not sown

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

Main results:

- The mean grass yield was only 0.4 t DM/ha.
- White clover ranged from 0.7 (timothy, chicory and plantain) to 1.4 t DM/ha (timothy).
- Subterranean clover failed to regenerate.
- Plantain yield (1.7 t DM/ha) was higher than chicory (0.2 t DM/ha).
- Timothy, white and subterranean clover decreased from year 2 to year 3. Plantain yield increased from 0.8 (Appendix 48) to 1.7 t DM/ha.

Individual Harvests: Year 1

Appendix 50. Harvested on 18 July 2007 rotation period: 30/1/-18/7/2007 (169 days).

	Botanical Composition (%)								Total Yield (kg DM/ha)
	Tim	White clover	Sub. clover	Chicory	Plantain	Red clover	Unsown species	Dead	
'Kahu' timothy	3	14 _a	51	-	-	-	2	31	173
'Kahu' timothy & chicory	17	7 _{bc}	47	6 _a	-	-	0	23	196
'Kahu' timothy & plantain	3	4 _c	42	-	11	-	2	38	221
'Kahu' timothy & chicory/plantain	7	8 _{bc}	31	0 _b	21	-	0	32	184
'Kahu' timothy & red clover	8	11 _{ab}	43	-	-	7	0	31	217
Mean	8	9	43	3*	16*		1	31	200
SEM	3.73	1.78	6.59	1.23	3.83	N/A	0.81	8.29	27.1
P value	0.130	0.04	0.368	0.021	0.387		0.408	0.778	0.680

Note: N/A = not applicable as there is only one treatment. * = means from two treatments. - = not sown
Treatment means followed by the same letter subscript are not significantly different.

Main results sowing – mid winter:

- Timothy is situated on the stoniest and therefore driest soil on the trial area.
- Yield of timothy pastures averaged 200 kg DM/ha. This is approximately 25% of that from ryegrass pastures over the same period (Appendix 17).
- There was a strong presence of subterranean clover (43%); while the timothy contributed only 8% to total yield with 9% from white clover.

Individual Harvests: Year 2

Appendix 51. Harvested on 5 November 2007 rotation period: 20/8/-5/11/2007 (77 days).

	Botanical Composition (%)								Total Yield (kg DM/ha)
	Tim	White clover	Sub. clover	Chicory	Plantain	Red clover	Unsown species	Dead	
'Kahu' timothy	8	51	29 _a	-	-	-	1	11 _{ab}	1421
'Kahu' timothy & chicory	7	59	16 _b	7	-	-	0	11 _{abc}	1908
'Kahu' timothy & plantain	4	63	5 _b	-	12	-	2	13 _a	1893
'Kahu' timothy & chicory/plantain	5	63	12 _b	4	7	-	1	8 _{bc}	1997
'Kahu' timothy & red clover	9	60	8 _b	-	-	16	0	6 _c	1712
Mean	7	59	14	6*	9*		1	10	1790
SEM	3.21	4.56	3.96	1.61	1.96	N/A	0.45	1.41	360
P value	0.783	0.403	0.018	0.624	0.317		0.064	0.05	0.801

Note: N/A = not applicable as there is only one treatment. * = means from two treatments. - = not sown
Treatment means followed by the same letter subscript are not significantly different.

Main results early spring – late spring:

- Yield averaged 1790 kg DM/ha with ~60% of that being from white clover and 14% subterranean clover.

Appendix 52. Harvested on 20 November 2007 rotation period: 20/8/-20/11/2007 (92 days).

	Botanical Composition (%)								Total Yield (kg DM/ha)
	Tim	White clover	Sub. clover	Chicory	Plantain	Red clover	Unsown species	Dead	
'Kahu' timothy	7	55	21	-	-	-	1	16	2759
'Kahu' timothy & chicory	9	55	7	14 _a	-	-	1	15	2894
'Kahu' timothy & plantain	12	47	17	-	14 _a	-	1	10	2477
'Kahu' timothy & chicory/plantain	9	52	12	5 _b	9 _b	-	2	11	2653
'Kahu' timothy & red clover	13	38	14	-	-	24	0	11	2231
Mean	10	49	14	9*	12*		1	13	2600
SEM	3.84	6.26	5.21	1.83	1.30	N/A	0.65	1.72	422
P value	0.778	0.342	0.453	0.227	0.139		0.668	0.136	0.821

Note: N/A = not applicable as there is only one treatment. * = means from two treatments. - = not sown
Treatment means followed by the same letter subscript are not significantly different.

Main results early spring – end of spring:

- The mean yield was 2.6 t DM/ha with 49% white clover, 14% subterranean clover and ~10% herbs.
- The timothy pastures yield was similar to dryland pastures (2.7 t DM/ha, Appendix 30) and ryegrass pastures (3.0 t DM/ha, Appendix 19) for the same period.
- Mean daily growth rate was 28 kg DM/ha/day for 92 day period.

Appendix 53. Harvested on 8 April 2008 rotation period: 1/12/2007-8/4/2008 (129 days).

	Botanical Composition (%)								Total Yield (kg DM/ha)
	Tim	White clover	Sub. clover	Chicory	Plantain	Red clover	Unsown species	Dead	
'Kahu' timothy	0	84 _a	0	-	-	-	1	14	863
'Kahu' timothy & chicory	6	71 _{ab}	0	11	-	-	0	12	815
'Kahu' timothy & plantain	2	34 _c	0	-	55	-	0	10	1150
'Kahu' timothy & chicory/plantain	1	42 _{bc}	0	1	42	-	0	13	960
'Kahu' timothy & red clover	0	80 _a	0	-	-	5	1	14	383
Mean	2	62	0	6*	49*		1	13	830
SEM	1.28	9.60	0.03	N/A	9.03	N/A	0.63	4.15	310
P value	0.085	0.019	0.461		0.594		0.461	0.913	0.541

Note: N/A = not applicable as there is only one treatment for red clover. Chicory unable to be statistically analysed due to insufficient sample (timothy and chicory n=1 and timothy, chicory and plantain n=2)* = means from two treatments. - = not sown
Treatment means followed by the same letter subscript are not significantly different.

Main results early summer – mid autumn:

- Total yield averaged 830 kg DM/ha but the timothy content was negligible.
- White clover was dominant particularly in the pastures without plantain or chicory.
- Plantain has increased from 12% (Appendix 52) to 49%.

Individual Harvests: Year 3

Appendix 54. Harvested on 21 October 2008 rotation period: 12/4/-21/10/2008 (192 days).

	Botanical Composition (%)								Total Yield (kg DM/ha)
	Tim	White clover	Sub. clover	Chicory	Plantain	Red clover	Unsovn species	Dead	
'Kahu' timothy	14	70	0	-	-	-	1	15	1092
'Kahu' timothy & chicory	26	44	0	13	-	-	2	14	1308
'Kahu' timothy & plantain	7	39	0	-	36	-	1	17	1553
'Kahu' timothy & chicory/plantain	21	28	0	2	37	-	0	12	1674
'Kahu' timothy & red clover	14	55	0	-	-	10	3	19	1384
Mean	16	47	0	8*	37*		2	15	1400
SEM	5.62	8.37	0.06	4.24	1.31	N/A	1.44	3.14	240
P value	0.223	0.057	0.569	0.217	0.857		0.699	0.678	0.516

Note: N/A = not applicable as there is only one treatment. * = means from two treatments. - = not sown

Main results mid autumn – mid spring:

- The mean yield was 1400 kg DM/ha with an average of 16% sown grass.
- White clover was the dominant species in this mix (47%).
- Subterranean clover failed to regenerate.
- This spring there was 1.4 t DM/ha compared with 2.6 t DM/ha in 2007.

Appendix 55. Harvested on 22 January 2009 rotation period: 7/11/2008-22/1/2009 (76 days).

	Botanical Composition (%)								Total Yield (kg DM/ha)
	Tim	White clover	Sub. clover	Chicory	Plantain	Red clover	Unsovn species	Dead	
'Kahu' timothy	12	63	0	-	-	-	0	25	403
'Kahu' timothy & chicory	10	44	0	6	-	-	1	36	498
'Kahu' timothy & plantain	0	17	0	-	64	-	8	11	652
'Kahu' timothy & chicory/plantain	8	25	0	2	37	1	0	26	684
'Kahu' timothy & red clover	13	40	0	-	-	1	9	19	417
Mean	9	38	0	4*	51*		4	23	530
SEM	5.95	9.67	0	N/A	25.0	N/A	4.68	6.66	93.7
P value	0.601	0.065	0		0.521		0.483	0.191	0.197

Note: N/A = not applicable as there is only one treatment for red clover. * = means from two treatments. - = not sown. Chicory unable to be statistically analysed due to insufficient sample (timothy and chicory n=1 and timothy, chicory and plantain n=1).

Main results late spring – mid summer:

- Mid summer yield was 530 kg DM/ha.
- Pastures sown with plantain contained 50% of this herb but chicory content was only 4%.
- White clover ranged from 17 (timothy and plantain) to 63% (timothy).
- Weed content continued to be low.

Appendix 56. Harvested on 19 March 2009 rotation period: 29/1/-19/3/2009 (49 days).

	Botanical Composition (%)								Standing Yield (kg DM/ha)
	Tim	White clover	Sub. clover	Chicory	Plantain	Red clover	Unsown species	Dead	
'Kahu' timothy	34 _a	37	0	-	-	-	18	11	310 _b
'Kahu' timothy & chicory	13 _{bc}	22	0	40	-	-	15	9	540 _b
'Kahu' timothy & plantain	2 _{cd}	12	0	-	61	-	18	7	1200 _a
'Kahu' timothy & chicory/plantain	0 _d	5	0	1	85	-	1	7	1136 _a
'Kahu' timothy & red clover	19 _b	29	0	-	-	3	19	4	357 _b
Mean	14	21	0	20*	73*		14	8	710
SEM	3.82	9.61	0.07	N/A	21.4	N/A	10.91	2.74	156
P value	<0.001	0.230	0.510		0.512		0.773	0.466	0.008

Note: N/A = not applicable as there is only one treatment for red clover. Chicory unable to be statistically analysed due to insufficient sample (timothy and chicory n=3 and timothy, chicory and plantain n=1).

* = means from two treatments. - = not sown

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

Main results mid summer – early autumn:

- Total yield ranged from 310 (timothy) to 1200 kg DM/ha due to the contribution of plantain (73%) when it was included.
- White clover had reduced from 38% (Appendix 55) to 21% and no subterranean clover was present.

Appendix 57. Harvested on 30 April 2009 rotation period: 29/1/-30/4/2009 (91 days).

	Botanical Composition (%)								Total Yield (kg DM/ha)
	Tim	White clover	Sub. clover	Chicory	Plantain	Red clover	Unsown species	Dead	
'Kahu' timothy	17 _{bc}	47 _a	0	-	-	-	28	10	564
'Kahu' timothy & chicory	35 _a	28 _{bc}	0	8	-	-	7	27	593
'Kahu' timothy & plantain	12 _{bc}	12 _c	0	-	72	-	0	18	1110
'Kahu' timothy & chicory/plantain	6 _c	14 _c	0	4	79	-	0	9	918
'Kahu' timothy & red clover	28 _{ab}	41 _{ab}	1	-	-	3	6	23	388
Mean	15	26	0	6*	76*		8	18	720
SEM	5.61	5.33	0.56	2.96	6.76	N/A	6.51	5.90	190
P value	0.032	0.005	0.461	0.451	0.537		0.077	0.224	0.140

Note: N/A = not applicable as there is only one treatment. * = means from two treatments. - = not sown. Timothy and white clover data is based on arcsine data.

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

Main results mid summer – mid autumn:

- The mean yield was 720 kg DM/ha.
- Timothy contributed from 6% (timothy, chicory and plantain) to 35% (timothy and chicory) of total DM yield.
- White clover continued to be the only clover of significance.

References

Cayley, J.W.D. and Bird, P.R. 1996. Techniques for Measure Pastures. 2nd Edition. Pastoral and Veterinary Institute, Hamilton, Vic. 51 pp.