**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 2 – Nutritive Value

Prepared by

Dr Derrick Moot

Professor of Plant Science

Lincoln University

New Zealand

August 2009

## *Appendices - Nutritive value*

### Summary of terminology.

- Nutritive value is a measure of a diets ability to meet animal requirements for maintenance and production (Waghorn *et al*. 2007).
- The potential feed value of a diet is defined as nutritive value x intake (Ulyatt 1981).
- Neutral detergent fibre (NDF) is cellulose, hemicellulose and lignin (cell wall), while acid detergent fibre (ADF) is cellulose and lignin (Burke *et al.* 2002). The hemicellulose component is readily digestible compared to cellulose and lignin. The latter is slower to degrade for ruminants (Waghorn *et al.* 2007).
- Van Soest (1965) suggests dry matter intake is influenced by the NDF level. As the NDF level increases (50-60% of DM) dry matter intake declines. This is supported by Ulyatt (1981).
- Perennial grass NDF parameters are compared to plant phenological (i.e. vegetative or reproductive) state as defined by Waghorn and Barry (1987).
- Metabolisable energy (ME) is the proportion of feed energy absorbed from the digestive tract and retained for metabolic processes and is considered to be a good indicator of nutritive value (Waghorn and Barry 1987).
- An adequate supply of nitrogen (N) in the soil promotes rapid plant growth and development of dark green coloured leaves (Stevenson 1982). N is often the most limiting nutrient in plant growth (Miller and Gardner 1998).
- Nitrogen is essential to many functions within the plant and is a primary constituent of the basic amino acids which are the building blocks of proteins. N is also a part of the chlorophyll molecule which is responsible for photosynthesis (McLaren and Cameron 1990).
- All nutritive values (NDF, ADF, N and ME) are determined by NIRS at Lincoln University.
- All results are based on sown species only.

## *Perennial Grasses*

### Background

### 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.

### Individual Harvests: Year 2

- Grass plots split in half. Half of each plot received 150 kg N/ha (+N) as calcium ammonium nitrate on 15 August 2007. The remaining half received no nitrogen (-N).
- Harvests for +N on 1 and 25 October, 5 and 20 November 2007 final harvest on 8 April 2008.
- Harvests for –N on 25 October and 20 November 2007.

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

| | | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|---|
| Species | Cultivar | ADF | NDF | N | ME |
| Ryegrass | 'Aries HD' 5 kg/ha | 19.7 | 40.2 | 4.5 | 11.7 |
| | 'Aries HD' 10 kg/ha | 19.4 | 43.1 | 5.3 | 11.5 |
| | 'Aries HD' 15kg/ha | 19.4 | 45.2 | 4.5 | 11.3 |
| | 'Cannon LE' | 19.9 | 42.5 | 4.7 | 11.7 |
| | 'Revolution' | 19.6 | 42.3 | 5.3 | 11.5 |
| Brome | 'Bareno' | 19.6 | 42.8 | 5.1 | 11.5 |
| | 'Gala' | 20.9 | 43.6 | 4.8 | 11.6 |
| Cocksfoot | 'Kara' | 19.9 | 42.8 | 5.2 | 11.5 |
| Tall fescue | 'Advance' | 18.9 | 39.7 | 5.0 | 12.1 |
| Timothy | 'Viking' | 19.8 | 44.5 | 5.2 | 11.5 |
| | Mean | 19.7 | 42.7 | 5.0 | 11.6 |
| | SEM | 0.47 | 1.85 | 0.36 | 0.16 |
| | P value | 0.414 | 0.591 | 0.566 | 0.247 |

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

- The ADF and NDF mean was 19.7 and 42.7% of DM respectively.
- The mean N was 5%.
- ME ranged from 11.3 for 'Aries HD' at 15kg/ha to 12.1 MJ/kg DM for tall fescue.

**Appendix 2. Harvested on 25 October 2007 (+ N) regrowth period: 15/8/-25/10/2007 (71 days).**

| | | % of Dry Matter | | | MJ/ kg DM |
|---|---|---|---|---|---|
| Species | Cultivar | ADF | NDF | N% | ME |
| Ryegrass | 'Aries HD' 5 kg/ha | $23.0_{bcd}$ | $46.0_{bcd}$ | 3.2 | $11.7_{ab}$ |
| | 'Aries HD' 10 kg/ha | $22.6_{cd}$ | $45.1_{cde}$ | 3.5 | $11.6_{abc}$ |
| | 'Aries HD' 15kg/ha | $24.5_{ab}$ | $48.6_{ab}$ | 2.7 | $11.4_{bc}$ |
| | 'Cannon LE' | $23.0_{bcd}$ | $47.5_{abc}$ | 3.4 | $11.3_{bc}$ |
| | 'Revolution' | $22.6_{cd}$ | $44.7_{cde}$ | 2.7 | $11.8_{a}$ |
| Brome | 'Bareno' | $22.8_{bcd}$ | $48.5_{ab}$ | 3.4 | $11.2_{cd}$ |
| | 'Gala' | $23.9_{abc}$ | $48.7_{ab}$ | 3.4 | $11.0_{d}$ |
| Cocksfoot | 'Kara' | $24.9_{a}$ | $50.5_{a}$ | 3.5 | $11.2_{cd}$ |
| Tall fescue | 'Advance' | $22.7_{cd}$ | $47.1_{bc}$ | 3.2 | $11.4_{bc}$ |
| Timothy | 'Viking' | $21.9_{d}$ | $42.3_{e}$ | 3.2 | $11.7_{ab}$ |
| | Mean | 23.2 | 46.9 | 3.2 | 11.4 |
| | SEM | 0.60 | 1.04 | 0.20 | 0.13 |
| | P value | 0.034 | <0.001 | 0.057 | 0.002 |

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

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

- ADF ranged from 21.9 (timothy) to 24.9% of DM (cocksfoot).
- Timothy had the lowest NDF (42.3% of DM), due to its later flowering date compared with ryegrasses. It remains vegetative for longer in spring.
- The mean nitrogen content was 3.2%.
- 'Revolution' had the highest ME (11.8 MJ/kg DM).
- Appendix 2 shows an increase in NDF from 42.7 (Appendix 1) to 46.9% of DM (Appendix 2). The majority of these grass species were at ear emergence where NDF is ~47% of DM (Waghorn and Barry 1987).

**Appendix 3. Harvested on 25 October 2007 (– N) regrowth period: 15/8/-25/10/2007 (71 days).**

| | | % of Dry Matter | | | MJ/ kg DM |
|---|---|---|---|---|---|
| Species | Cultivar | ADF | NDF | N% | ME |
| Ryegrass | 'Aries HD' 5 kg/ha | $22.9_{cd}$ | $45.4_{de}$ | $2.2_{cde}$ | $11.8_{b}$ |
| | 'Aries HD' 10 kg/ha | $23.4_{cd}$ | $47.0_{cd}$ | $2.6_{abc}$ | $11.5_{bc}$ |
| | 'Aries HD' 15kg/ha | $23.8_{bcd}$ | $45.9_{de}$ | $2.2_{bcde}$ | $11.5_{bc}$ |
| | 'Cannon LE' | $23.7_{cd}$ | $46.6_{cde}$ | $2.1_{bcde}$ | $11.5_{bc}$ |
| | 'Revolution' | $21.7_{de}$ | $43.2_{e}$ | $1.9_{e}$ | $12.1_{ab}$ |
| Brome | 'Bareno' | $25.2_{bc}$ | $50.5_{ab}$ | $2.6_{ab}$ | $10.7_{d}$ |
| | 'Gala' | $27.9_{a}$ | $53.5_{a}$ | $2.4_{abcd}$ | $10.1_{e}$ |
| Cocksfoot | 'Kara' | $26.1_{ab}$ | $51.3_{ab}$ | $2.8_{a}$ | $10.7_{de}$ |
| Tall fescue | 'Advance' | $24.7_{bc}$ | $49.7_{bc}$ | $2.1_{de}$ | $11.0_{cd}$ |
| Timothy | 'Viking' | $19.7_{e}$ | $37.3_{f}$ | $1.9_{e}$ | $12.3_{a}$ |
| | Mean | 24.0 | 47.0 | 2.3 | 11.3 |
| | SEM | 0.83 | 1.19 | 0.16 | 0.19 |
| | P value | <0.001 | <0.001 | <0.001 | 0.006 |

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

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

- ADF ranged from 19.7 (timothy) to 27.9% of DM ('Gala').
- 'Gala' had the highest NDF (53.5% of DM).
- Timothy had the lowest NDF (37.3% of DM) and N (1.9%) but the highest ME (12.3 MJ/kg DM).
- Appendix 3 shows similar NDF levels to grasses receiving N (47% of DM, Appendix 2). This shows the maturity of grasses was similar but yield was 780 kg DM/ha for –N (See Appendix 6; Botanical composition) and 2200 kg DM/ha for +N (See Appendix 5; botanical composition).

**Appendix 4. Harvested on 5 November 2007 (+N) regrowth period: 15/8/-5/11/2007 (82 days).**

| | | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|---|
| Species | Cultivar | ADF | NDF | N% | ME |
| Ryegrass | 'Aries HD' 5 kg/ha | 24.7 $_{bcd}$ | 50.0 $_{b}$ | 2.7 $_{cd}$ | 11.6 $_{abc}$ |
| | 'Aries HD' 10 kg/ha | 24.1 $_{cd}$ | 49.3 $_{bc}$ | 2.9 $_{bcd}$ | 11.6 $_{ab}$ |
| | 'Aries HD' 15kg/ha | 24.5 $_{bcd}$ | 50.6 $_{b}$ | 2.9 $_{bcd}$ | 11.5 $_{abc}$ |
| | 'Cannon LE' | 24.4 $_{cd}$ | 50.4 $_{b}$ | 2.8 $_{bcd}$ | 11.5 $_{abc}$ |
| | 'Revolution' | 23.8 $_{cd}$ | 49.7 $_{b}$ | 2.6 $_{d}$ | 11.7 $_{a}$ |
| Brome | 'Bareno' | 25.7 $_{abc}$ | 56.0 $_{a}$ | 3.1 $_{abc}$ | 11.1 $_{bcd}$ |
| | 'Gala' | 26.4 $_{ab}$ | 54.9 $_{a}$ | 3.4 $_{a}$ | 10.4 $_{e}$ |
| Cocksfoot | 'Kara' | 27.1 $_{a}$ | 55.8 $_{a}$ | 3.1 $_{abc}$ | 11.0 $_{cde}$ |
| Tall fescue | 'Advance' | 26.3 $_{ab}$ | 54.7 $_{a}$ | 3.3 $_{ab}$ | 10.6 $_{de}$ |
| Timothy | 'Viking' | 23.1 $_{d}$ | 45.7 $_{c}$ | 2.6 $_{d}$ | 11.7 $_{a}$ |
| | Mean | 25.0 | 51.7 | 2.9 | 11.3 |
| | SEM | 0.67 | 1.32 | 0.15 | 0.20 |
| | P value | 0.004 | <0.001 | <0.001 | 0.008 |

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

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

- Cocksfoot had the highest ADF (27.1% DM)
- The mean NDF was 51.7% of DM and mean N was 2.9%.
- Timothy and 'Revolution' had the highest ME (11.7 MJ/kg DM).
- Overall fibre increased and N% and ME decreased since 1 October (Appendix 1).

**Appendix 5. Harvested on 20 November 2007 (+N) regrowth period: 15/8/-20/11/2007 (97 days).**

| | | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|---|
| Species | Cultivar | ADF | NDF | N% | ME |
| Ryegrass | 'Aries HD' 5 kg/ha | 25.4 $_{de}$ | 50.7 $_{b}$ | 2.4 | 11.4 $_{ab}$ |
| | 'Aries HD' 10 kg/ha | 25.3 $_{de}$ | 50.5 $_{b}$ | 2.5 | 11.4 $_{ab}$ |
| | 'Aries HD' 15kg/ha | 25.2 $_{de}$ | 51.1 $_{b}$ | 2.6 | 11.3 $_{bc}$ |
| | 'Cannon LE' | 25.5 $_{cde}$ | 51.2 $_{b}$ | 2.3 | 11.3 $_{ab}$ |
| | 'Revolution' | 24.1 $_{e}$ | 48.8 $_{bc}$ | 2.1 | 11.7 $_{a}$ |
| Brome | 'Bareno' | 27.4 $_{abc}$ | 57.4 $_{a}$ | 2.6 | 10.9 $_{d}$ |
| | 'Gala' | 27.9 $_{ab}$ | 58.6 $_{a}$ | 2.9 | 10.6 $_{d}$ |
| Cocksfoot | 'Kara' | 28.8 $_{a}$ | 58.5 $_{a}$ | 2.5 | 10.9 $_{cd}$ |
| Tall fescue | 'Advance' | 26.3 $_{bcd}$ | 55.6 $_{a}$ | 2.6 | 10.9 $_{d}$ |
| Timothy | 'Viking' | 23.8 $_{e}$ | 46.5 $_{c}$ | 2.7 | 11.6 $_{ab}$ |
| | Mean | 26.0 | 52.9 | 2.5 | 11.2 |
| | SEM | 2.0 | 1.18 | 0.18 | 0.14 |
| | P value | <0.001 | <0.001 | 0.240 | <0.001 |

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

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

- The mean ADF was 26.0% of DM and was highest in cocksfoot.
- The lowest NDF was 46.5% of DM in timothy.
- 'Revolution' had the highest ME (11.7 MJ/kg DM), while the drought tolerant species such as the bromes, cocksfoot and tall fescue had a lower ME of 10.8 MJ/kg DM.
- The mean N was 2.5%.
- NDF increased from 42.7 (Appendix 1) to 52.9% of DM (Appendix 5) over 50 days.

**Appendix 6. Harvested on 20 November 2007 (–N) regrowth period: 15/8/-20/11/2007 (97 days).**

| | | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|---|
| Species | Cultivar | ADF | NDF | N | ME |
| Ryegrass | 'Aries HD' 5 kg/ha | 26.9 $_{bc}$ | 52.9 $_{b}$ | 1.5 $_{bcde}$ | 11.1 $_{bcd}$ |
| | 'Aries HD' 10 kg/ha | 26.3 $_{bc}$ | 51.6 $_{bc}$ | 1.5 $_{bcde}$ | 11.3 $_{bc}$ |
| | 'Aries HD' 15kg/ha | 26.8 $_{bc}$ | 52.2 $_{bc}$ | 1.5 $_{bcd}$ | 11.1 $_{bcd}$ |
| | 'Cannon LE' | 26.8 $_{bc}$ | 52.0 $_{bc}$ | 1.3 $_{cde}$ | 11.0 $_{cd}$ |
| | 'Revolution' | 24.2 $_{c}$ | 48.8 $_{c}$ | 1.3 $_{de}$ | 11.7 $_{b}$ |
| Brome | 'Bareno' | 27.6 $_{b}$ | 54.2 $_{b}$ | 1.7 $_{ab}$ | 10.6 $_{d}$ |
| | 'Gala' | 32.5 $_{a}$ | 60.3 $_{a}$ | 1.6 $_{bcd}$ | 9.4 $_{e}$ |
| Cocksfoot | 'Kara' | 26.9 $_{bc}$ | 52.4 $_{bc}$ | 1.6 $_{bc}$ | 11.2 $_{bc}$ |
| Tall fescue | 'Advance' | 26.6 $_{bc}$ | 54.5 $_{b}$ | 2.0 $_{a}$ | 10.7 $_{cd}$ |
| Timothy | 'Viking' | 19.7 $_{d}$ | 38.6 $_{d}$ | 1.2 $_{e}$ | 12.5 $_{a}$ |
| | Mean | 26.4 | 51.8 | 1.5 | 11.1 |
| | SEM | 1.00 | 1.27 | 0.11 | 0.22 |
| | P value | <0.001 | <0.001 | <0.001 | 0.001 |

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

**Main results late winter – early spring (-N):**

- The ADF was highest at 32.5% of DM for 'Gala' and lowest for timothy (19.7% of DM).
- In contrast, NDF ranged from 38.6 (timothy) to 60.3% of DM ('Gala')
- N was the highest in tall fescue (2.0%) and lowest in timothy (1.2%).
- ME followed an inverse trend to NDF where 'Gala' had the lowest (9.4 MJ/kg DM) and timothy had the highest (12.5 MJ/kg DM).

**Appendix 7. Harvested on 8 April 2008 (+N) regrowth period: 17/1/-8/4/2008 (82 days).**

| | | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|---|
| Species | Cultivar | ADF | NDF | N | ME |
| Ryegrass | 'Aries HD' 5 kg/ha | 19.0 $_{de}$ | 43.4 $_{cde}$ | 2.2 | 12.5 $_{ab}$ |
| | 'Aries HD' 10 kg/ha | 17.8 $_{e}$ | 40.5 $_{ef}$ | 1.8 | 13.1 $_{a}$ |
| | 'Aries HD' 15kg/ha | 18.1 $_{cde}$ | 41.7 $_{cdef}$ | 1.8 | 13.1 $_{a}$ |
| | 'Cannon LE' | 20.3 $_{cd}$ | 44.6 $_{cd}$ | 1.8 | 12.7 $_{a}$ |
| | 'Revolution' | 18.4 $_{de}$ | 41.4 $_{cdef}$ | 2.0 | 13.1 $_{a}$ |
| Brome | 'Bareno' | 24.4 $_{a}$ | 52.3 $_{a}$ | 2.1 | 10.7 $_{d}$ |
| | 'Gala' | 23.3 $_{ab}$ | 50.5 $_{ab}$ | 2.7 | 11.1 $_{d}$ |
| Cocksfoot | 'Kara' | 25.2 $_{a}$ | 54.1 $_{a}$ | 1.8 | 11.4 $_{cd}$ |
| Tall fescue | 'Advance' | 21.0 $_{bc}$ | 47.5 $_{bc}$ | 2.2 | 11.8 $_{bc}$ |
| Timothy | 'Viking' | 17.3 $_{e}$ | 38.0 $_{f}$ | 2.2 | 12.7 $_{a}$ |
| | Mean | 20.5 | 45.4 | 2.1 | 12.2 |
| | SEM | 0.80 | 1.26 | 0.21 | 0.25 |
| | P value | <0.001 | <0.001 | 0.115 | <0.001 |

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

Note: All plots (both +N and –N) had an autumn N application of 46 kg N/ha (as urea) on 19/2/2008.Visual symptoms of N deficiency were evident in –N treatments, therefore 50 kg N/ha (urea) was also applied on 18/3/2008 to –N treatments only.

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

- ADF (~25% of DM) and NDF (~53% of DM) were highest in 'Bareno' and cocksfoot and lowest (17.3 and 38.0% of DM) in timothy.
- The mean N was 2.1%.
- The drought tolerant species (bromes, cocksfoot and tall fescue) had an ME of 11.3 MJ/kg DM which was lower than the ryegrasses (~12.9)and timothy (~12.7).

## Year 3

**Appendix 8. Harvested on 10 September 2008 rotation period: 11/4/-10/9/2008 (152 days).**

| | | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|---|
| Species | Cultivar | ADF | NDF | N | ME |
| Ryegrass | 'Aries HD' 5 kg/ha | 20.9 $_{bc}$ | 42.5 $_{b}$ | 2.6 $_{cde}$ | 12.2 $_{a}$ |
| | 'Aries HD' 10 kg/ha | 21.4 $_{b}$ | 43.9 $_{b}$ | 2.1 $_{e}$ | 12.2 $_{a}$ |
| | 'Aries HD' 15kg/ha | 21.4 $_{b}$ | 43.6 $_{b}$ | 2.5 $_{de}$ | 12.1 $_{a}$ |
| | 'Cannon LE' | 21.1 $_{b}$ | 43.7 $_{b}$ | 2.5 $_{de}$ | 12.2 $_{a}$ |
| | 'Revolution' | 21.0 $_{bc}$ | 42.6 $_{b}$ | 2.4 $_{de}$ | 12.4 $_{a}$ |
| Brome | 'Bareno' | 23.9 $_{a}$ | 49.3 $_{a}$ | 3.0 $_{abc}$ | 11.2 $_{bc}$ |
| | 'Gala' | 24.0 $_{a}$ | 50.0 $_{a}$ | 3.2 $_{a}$ | 11.2 $_{c}$ |
| Cocksfoot | 'Kara' | 23.4 $_{a}$ | 49.4 $_{a}$ | 3.3 $_{a}$ | 11.6 $_{b}$ |
| Tall fescue | 'Advance' | 23.0 $_{a}$ | 48.4 $_{a}$ | 2.7 $_{bcd}$ | 11.5 $_{bc}$ |
| Timothy | 'Viking' | 19.9 $_{c}$ | 37.6 $_{c}$ | 3.1 $_{ab}$ | 12.1 $_{a}$ |
| | Mean | 22.0 | 45.1 | 2.7 | 11.9 |
| | SEM | 0.41 | 0.67 | 0.16 | 0.12 |
| | P value | <0.001 | <0.001 | <0.001 | <0.001 |

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

**Main results mid autumn – early spring:**

- ADF and NDF were highest for drought tolerant species (bromes, tall fescue and cocksfoot) at 23.6 and 49.3% of DM, respectively and were lowest in timothy (19.9 and 37.6% of DM respectively).
- The highest ME was ~12.2 MJ/kg DM in ryegrasses and timothy.
- N ranged from 2.1% ('Aries HD'10 kg/ha) to 3.3% (cocksfoot).

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

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

| | | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|---|
| Species | Cultivar | ADF | NDF | N | ME |
| Ryegrass | 'Aries HD' 5 kg/ha | 22.6 $_{c}$ | 44.1 $_{de}$ | 2.3 $_{d}$ | 12.0 $_{ab}$ |
| | 'Aries HD' 10 kg/ha | 24.1 $_{b}$ | 46.6 $_{cd}$ | 2.6 $_{c}$ | 11.8 $_{bc}$ |
| | 'Aries HD' 15kg/ha | 22.5 $_{c}$ | 44.2 $_{de}$ | 2.2 $_{d}$ | 12.0 $_{ab}$ |
| | 'Cannon LE' | 22.3 $_{cd}$ | 44.5 $_{cde}$ | 2.0 $_{e}$ | 12.2 $_{ab}$ |
| | 'Revolution' | 21.4 $_{cd}$ | 43.3 $_{e}$ | 2.1 $_{de}$ | 12.5 $_{a}$ |
| Brome | 'Bareno' | 26.0 $_{a}$ | 51.0 $_{ab}$ | 3.3 $_{a}$ | 11.0 $_{d}$ |
| | 'Gala' | 26.2 $_{a}$ | 52.2 $_{a}$ | 2.9 $_{b}$ | 10.9 $_{d}$ |
| Cocksfoot | 'Kara' | 25.1 $_{ab}$ | 50.9 $_{ab}$ | 3.2 $_{a}$ | 11.4 $_{cd}$ |
| Tall fescue | 'Advance' | 25.4 $_{ab}$ | 50.2 $_{bc}$ | 3.1 $_{b}$ | 11.2 $_{cd}$ |
| Timothy | 'Viking' | 21.1 $_{d}$ | 40.2$_{f}$ | 2.5 $_{c}$ | 12.2 $_{ab}$ |
| | Mean | 23.6 | 46.7 | 2.6 | 11.8 |
| | SEM | 0.39 | 0.86 | 0.16 | 0.14 |
| | P value | <0.001 | <0.001 | <0.001 | 0.003 |

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

**Main results early spring – mid spring:**

- ADF ranged from 21.1 (timothy) to 26.0% of DM (bromes).
- NDF was higher for bromes and cocksfoot than ryegrasses.
- Cocksfoot and 'Bareno' had the highest N (3.3%) and timothy had the lowest (2.5%).
- ME was higher in ryegrasses and timothy than bromes, cocksfoot and tall fescue.
- Grasses grazed earlier this year to accommodate a field day in November; hence majority of grasses did not reach reproductive state.
- DM yield was measured on 14/1/2009 but these were insufficient for NIRS analysis.

**Appendix 10. Harvested on 21 April 2009 rotation length: 29/1/-21/4/2009 (82 days).**

| | | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|---|
| Species | Cultivar | ADF | NDF | N | ME |
| Ryegrass | 'Aries HD' 5 kg/ha | 20.2 $_{b}$ | 41.2 $_{bc}$ | 2.0 $_{bc}$ | 12.8 $_{a}$ |
| | 'Aries HD' 10 kg/ha | 19.7 $_{b}$ | 40.4 $_{bc}$ | 1.8 $_{bc}$ | 12.8 $_{a}$ |
| | 'Aries HD' 15kg/ha | 20.0 $_{b}$ | 41.8 $_{bc}$ | 2.2 $_{abc}$ | 12.8 $_{a}$ |
| | 'Cannon LE' | 19.6 $_{b}$ | 41.0 $_{bc}$ | 1.9 $_{bc}$ | 12.8 $_{a}$ |
| | 'Revolution' | 20.4 $_{b}$ | 42.1 $_{b}$ | 1.7 $_{c}$ | 12.8 $_{a}$ |
| Brome | 'Bareno' | 25.8 $_{a}$ | 52.7 $_{a}$ | 2.3 $_{ab}$ | 10.8 $_{d}$ |
| | 'Gala' | - | - | - | - |
| Cocksfoot | 'Kara' | 25.8 $_{a}$ | 52.9 $_{a}$ | 1.8 $_{c}$ | 11.6 $_{c}$ |
| Tall fescue | 'Advance' | - | - | - | - |
| Timothy | 'Viking' | 18.5 $_{b}$ | 38.1 $_{c}$ | 2.6 $_{a}$ | 12.4 $_{ab}$ |
| | Mean | 21.2 | 43.7 | 2.0 | 12.3 |
| | SEM | 0.82 | 1.22 | 0.15 | 0.19 |
| | P value | 0.002 | <0.001 | 0.045 | 0.001 |

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

**Main results mid summer – late autumn:**

- No 'Gala' or tall fescue nutritive parameters available for 21 April 2009 (Appendix 10) due to insufficent sample size.
- 'Bareno' and cocksfoot had the highest ADF and NDF (25.8 and 52.8% DM respectively).
- The highest N was from timothy (2.6%).
- ME was lowest at 10.8 MJ kg DM for 'Bareno' compared with ryegrasses (12.8 MJ/kg DM), timothy (12.4 MJ kg DM) and cocksfoot (11.6 MJ kg DM).

## *Nutritive value – 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.

<u>New sowing on 28th February 2008</u>

- 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.
- Nutritive value of perennial ryegrass is affected by developmental phase while legumes have a more consistent composition (Waghorn *et al*. 2007).
- Legumes retain a higher digestibility than grass leaf of comparable maturity due to their maintenance of higher leaf to stem ratio. More stalky legumes such as lucerne and red clover maybe similar to grass as the leaf: stem ratio decreases as maturity increases (Waghorn and Barry 1987).

## Year 2

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

| | | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|---|
| Species | Cultivar | ADF | NDF | N | ME |
| Lucerne | 'Kaituna' | 24.0 $_{ab}$ | 30.2 $_{b}$ | 3.5 $_{c}$ | 11.2 $_{b}$ |
| Red clover | 'Pawera' | 22.0 $_{bc}$ | 27.8 $_{bc}$ | 3.6 $_{bc}$ | 10.6 $_{b}$ |
| White clover | 'Demand' | 18.2 $_{f}$ | 23.4 $_{e}$ | 4.1 $_{a}$ | 12.0 $_{a}$ |
| Caucasian clover (Cc) | 'Endura' | 20.6 $_{cde}$ | 25.7 $_{cde}$ | 3.6 $_{bc}$ | 11.8 $_{a}$ |
| Alsike clover | | 18.3 $_{ef}$ | 24.0 $_{de}$ | 4.0 $_{ab}$ | 12.0 $_{a}$ |
| Subterranean | 'Leura' | 24.2 $_{a}$ | 29.6 $_{b}$ | 2.7 $_{d}$ | 10.9 $_{b}$ |
| Balansa | 'Bolta' | 19.6 $_{def}$ | 24.8 $_{de}$ | 4.0 $_{ab}$ | 11.8 $_{a}$ |
| Chicory | 'Choice' | 20.7 $_{cd}$ | 25.2 $_{de}$ | 2.4 $_{de}$ | 11.4 $_{b}$ |
| Plantain | 'Tonic' | 24.9 $_{a}$ | 34.7 $_{a}$ | 2.1 $_{e}$ | 10.3 $_{b}$ |
| | Mean | 21.4 | 27.3 | 3.3 | 11.3 |
| | SEM | 0.70 | 0.83 | 0.15 | 0.12 |
| | P value | <0.001 | <0.001 | <0.001 | <0.001 |

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

**Main results mid winter – late spring:**

- ADF was highest in subterranean clover and plantain (24.6%).
- NDF ranged from 23.4 (white clover) to 34.7% DM (plantain).
- N was lower for plantain (2.1%) and chicory (2.4%) than most clovers.
- White, Caucasian, alsike and balansa clovers had higher ME (11.9 MJ/kg DM) than other species (10.3 – 11.4 MJ/kg DM).

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

| | | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|---|
| Species | Cultivar | ADF | NDF | N | ME |
| Lucerne | 'Kaituna' | 22.9 $_{a}$ | 27.6 $_{a}$ | 3.0 $_{ab}$ | 11.2 $_{d}$ |
| Red clover | 'Pawera' | 21.7 $_{ab}$ | 25.9 $_{ab}$ | 3.1 $_{ab}$ | 10.7 $_{e}$ |
| White clover | 'Demand' | 17.4 $_{d}$ | 21.6 $_{de}$ | 3.2 $_{a}$ | 12.0 $_{a}$ |
| Caucasian clover (Cc) | 'Endura' | 19.5 $_{c}$ | 24.2 $_{bc}$ | 3.1 $_{ab}$ | 11.4 $_{cd}$ |
| Alsike clover | | 17.0 $_{d}$ | 22.2 $_{cd}$ | 3.4 $_{a}$ | 11.8 $_{ab}$ |
| Subterranean | 'Leura' | 15.8 $_{b}$ | 22.4 $_{c}$ | 2.8 $_{bc}$ | 10.8 $_{e}$ |
| Balansa | 'Bolta' | 12.1 $_{d}$ | 20.0 $_{e}$ | 3.3 $_{a}$ | 12.1 $_{a}$ |
| Chicory | 'Choice' | 19.1 $_{c}$ | 22.2 $_{cd}$ | 2.5 $_{c}$ | 11.5 $_{bc}$ |
| Plantain | 'Tonic' | 18.8 $_{c}$ | 27.4 $_{a}$ | 1.7 $_{d}$ | 11.5 $_{bcd}$ |
| | Mean | 19.3 | 23.7 | 2.9 | 11.5 |
| | SEM | 0.42 | 0.71 | 0.13 | 0.11 |
| | P value | <0.001 | <0.001 | <0.001 | <0.001 |

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

**Main results early summer – mid autumn:**

- ADF was highest in lucerne and red clover and lowest in white, balansa and alsike clovers.
- Plantain, red clover and lucerne had the highest NDF (27.8% of DM) but these levels are never >35 and hence remains more digestible than perennial grasses (Appendix 7).
- In most cases N% was higher in the legumes than herbs.
- White, Caucasian, alsike and balansa clovers had higher ME (12.0 MJ/kg DM) than the herbs and stemmy legumes.

## Year 3

- Strawberry and subterranean clover (Denmark) was sown 28/2/2008.

**Appendix 13. Harvested on 21 October 2008 regrowth period: 10/4/-21/10/2008 (194 days).**

| | | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|---|
| Species | Cultivar | ADF | NDF | N | ME |
| Lucerne | 'Kaituna' | 22.0 $_{a}$ | 27.3 $_{a}$ | 4.1 $_{a}$ | 11.3 $_{cd}$ |
| Red clover | 'Pawera' | 21.6 $_{a}$ | 27.1 $_{a}$ | 3.9 $_{a}$ | 10.9 $_{e}$ |
| White clover | 'Demand' | 18.2 $_{d}$ | 23.3 $_{c}$ | 4.2 $_{a}$ | 12.1 $_{a}$ |
| Caucasian clover (Cc) | 'Endura' | 20.3 $_{c}$ | 24.2 $_{bc}$ | 3.9 $_{a}$ | 11.6 $_{bc}$ |
| Alsike clover | | 18.2 $_{d}$ | 23.6 $_{bc}$ | 3.9 $_{a}$ | 12.0 $_{a}$ |
| Subterranean | 'Leura' | 20.9 $_{ab}$ | 25.1 $_{b}$ | 3.2 $_{b}$ | 11.2 $_{d}$ |
| Balansa | 'Bolta' | 18.4 $_{d}$ | 23.4 $_{c}$ | 4.2 $_{a}$ | 11.9 $_{ab}$ |
| Chicory | 'Choice' | 19.1 $_{cd}$ | 23.4 $_{c}$ | 3.1 $_{bc}$ | 11.5 $_{cd}$ |
| Plantain | 'Tonic' | 19.1 $_{cd}$ | 27.5 $_{a}$ | 2.8 $_{bc}$ | 11.3 $_{cd}$ |
| | Mean | 19.9 | 25.1 | 3.6 | 11.5 |
| | SEM | 0.44 | 0.57 | 0.17 | 0.13 |
| | P value | <0.001 | <0.001 | <0.001 | <0.001 |

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

**Main results mid autumn – mid spring:**

- ADF was highest in lucerne, subterranean and red clovers and lowest in balansa, alsike and white clovers.
- NDF was highest in lucerne, red clover and plantain (27.3% of DM). Waghorn *et al.* (2007) note lucerne stem (NDF) percentage is similar to perennial ryegrasses after 8-9 weeks regrowth. Despite having similar stem proportion lucerne still has a lower NDF and hence is still more digestible compared with perennial ryegrass (Appendices 2 and 3).
- In most cases N% was higher in legumes than herbs.
- The ME ranged from 10.9 (red clover) to 12.1 MJ/kg DM (white and alsike clovers).

Note grazing occurred 31/10/-7/11/2007.

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

| | | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|---|
| Species | Cultivar | ADF | NDF | N | ME |
| Lucerne | 'Kaituna' | 25.3 $_{a}$ | 31.8 $_{b}$ | 3.7 $_{a}$ | 10.9 $_{a}$ |
| Red clover | 'Pawera' | 24.2 $_{ab}$ | 30.7 $_{bc}$ | 3.4 $_{ab}$ | 10.6 $_{a}$ |
| White clover | 'Demand' | 18.9 $_{b}$ | 25.2 $_{ef}$ | 3.8 $_{a}$ | 11.7 $_{a}$ |
| Caucasian clover (Cc) | 'Endura' | 21.6 $_{b}$ | 28.5 $_{cd}$ | 3.9 $_{a}$ | 11.5 $_{a}$ |
| Alsike clover | | 18.1 $_{b}$ | 24.3 $_{f}$ | 3.8 $_{a}$ | 11.6 $_{a}$ |
| Subterranean | 'Leura' | - | - | - | - |
| Balansa | 'Bolta' | - | - | - | - |
| Subterranean & | 'Denmark' | 29.5 $_{a}$ | 35.1 $_{a}$ | 2.4 $_{c}$ | 9.1 $_{b}$ |
| Strawberry | 'Lucila' | - | - | - | - |
| Chicory | 'Choice' | 21.9 $_{b}$ | 27.8 $_{de}$ | 3.0 $_{b}$ | 11.0 $_{a}$ |
| Plantain | 'Tonic' | 23.2 $_{ab}$ | 35.0 $_{a}$ | 2.1 $_{c}$ | 10.2 $_{a}$ |
| | Mean | 22.8 | 29.9 | 3.0 | 9.7 |
| | SEM | 2.44 | 0.95 | 0.19 | 0.72 |
| | P value | <0.001 | <0.001 | <0.001 | <0.001 |

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

**Main results late spring – mid summer:**

- There was insufficient sample for balansa, 'Leura' subterranean and strawberry clovers for NIRS.

- ADF was higher in 'Denmark' subterranean clover and lucerne than the other clovers and chicory.

- NDF of subterranean clover (35.1 % of DM) was higher than other legumes due to its runners for seed burial. Plantain was also high (35.0% of DM) in NDF compared with chicory (27.8% of DM) and the clovers.

- Legume and herbs peak NDF levels occur in January (30% of DM), compared with perennial grasses in November (53% of DM Appendix 5).

- Perennial legumes had a higher N% (3.7) compared with herbs and annual clover (2.5%).

- ME ranged from 9.1 ('Denmark' clover) to 11.7 MJ/kg DM (white clover).

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

**Appendix 15. Harvest on 21 April 2009 regrowth period: 29/1/-21/4/2009 (82 days).**

| | | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|---|
| Species | Cultivar | ADF | NDF | N | ME |
| Lucerne | 'Kaituna' | 26.1 $_{a}$ | 33.3 $_{a}$ | 3.5 $_{cd}$ | 10.7 $_{d}$ |
| Red clover | 'Pawera' | 22.5 $_{b}$ | 29.4 $_{b}$ | 3.8 $_{b}$ | 10.4 $_{e}$ |
| White clover | 'Demand' | 18.4 $_{de}$ | 25.6 $_{cd}$ | 4.1 $_{a}$ | 11.6 $_{ab}$ |
| Caucasian clover (Cc) | 'Endura' | 20.2 $_{c}$ | 27.7 $_{bc}$ | 3.7 $_{bc}$ | 11.3 $_{c}$ |
| Alsike clover | | 18.1 $_{e}$ | 25.9 $_{cd}$ | 4.3 $_{a}$ | 11.7 $_{a}$ |
| Subterranean | 'Leura' | 19.4 $_{cd}$ | 24.6 $_{d}$ | 4.2 $_{a}$ | 10.6 $_{de}$ |
| Balansa | 'Bolta' | - | - | - | - |
| Subterranean & | 'Denmark' | 20.0 $_{c}$ | 24.0 $_{d}$ | 3.3 $_{d}$ | 10.1 $_{f}$ |
| Strawberry | 'Lucila' | 20.1 $_{c}$ | 29.7 $_{b}$ | 4.1 $_{a}$ | 11.5 $_{abc}$ |
| Chicory | 'Choice' | - | - | - | - |
| Plantain | 'Tonic' | 18.8 $_{de}$ | 29.7 $_{b}$ | 2.0 $_{e}$ | 11.4 $_{bc}$ |
| | Mean | 20.4 | 27.8 | 3.7 | 11.0 |
| | SEM | 0.38 | 0.80 | 0.07 | 0.08 |
| | P value | <0.001 | <0.001 | <0.001 | <0.001 |

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

**Main results mid summer – late autumn:**

- Lucerne had the highest ADF and NDF (26.1 and 33.3% of DM, respectively).

- N ranged from 2.0 (plantain) to over 4% for most clovers.

- Alsike clover had the highest ME (11.7) and N% (4.3) compared with other legumes and herbs.

# 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 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.
- White and subterranean clovers are represented by the men value across treatments.

### Year 1

**Appendix 16. Harvested on 18 July 2007 rotation period: 30/1/-18/7/2007 (169 days).**

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Cultivar | ADF | NDF | N | ME |
| *White clover* | *18.8* | *30.9* | *3.4* | *11.5* |
| *Subterranean clover* | *22.7* | *27.7* | *3.0* | *10.2* |
| 'Revolution' AR1 10 kg/ha | 17.8 | 41.4 | 2.7 | 12.4 |
| 'Revolution' AR1 20 kg/ha | 19.3 | 37.2 | 2.4 | 11.7 |
| 'Revolution' AR1 10 kg/ha & 'Dg25' cocksfoot | 18.7<br>- | 41.6<br>- | 2.6<br>- | 12.2<br>- |
| 'Cannon' HE 10 kg/ha | 17.6 | 42.1 | 2.8 | 12.1 |
| 'Samson' AR1 10 kg/ha | 18.0 | 40.5 | 2.2 | 12.5 |
| Mean* | 18.2 | 40.1 | 2.5 | 12.2 |
| SEM* | 0.93 | 2.08 | 0.13 | 0.37 |
| P value* | 0.692 | 0.504 | 0.717 | 0.086 |

Note - = sample size inadequate for analysis. * = for ryegrass/cocksfoot only.

**Main results sowing – mid winter:**

- The mean ADF was 18.2% of DM for grasses and 20.8% of DM for clovers.
- NDF ranged from 37.2 ('Revolution' 20 kg/ha) to 42.1% of DM ('Cannon HE').
- The mean N was 2.5% for grasses and 3.2% for clovers.
- The mean ME was 12.2 MJ/kg DM.

## Year 2

**Appendix 17. Harvested on 5 November 2007 rotation period: 20/8/-5/11/2007 (77 days).**

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Cultivar | ADF | NDF | N | ME |
| *White clover* | *18.7* | *21.6* | *4.3* | *12.1* |
| *Subterranean clover* | *23.9* | *27.7* | *3.1* | *10.4* |
| 'Revolution' AR1 10 kg/ha | 25.0 | 44.6 | 1.9 | 11.4 |
| 'Revolution' AR1 20 kg/ha | 24.3 | 44.7 | 1.9 | 11.7 |
| 'Revolution' AR1 10 kg/ha & | 24.8 | 42.3 | 1.7 | 11.2 |
| 'Dg25' cocksfoot | - | - | - | - |
| 'Cannon' HE 10 kg/ha | 26.1 | 47.7 | 1.7 | 11.0 |
| 'Samson' AR1 10 kg/ha | - | - | - | - |
| Mean* | 25.1 | 44.8 | 1.8 | 11.3 |
| SEM* | 0.807 | 1.07 | 0.157 | 0.354 |
| P value* | 0.498 | 0.062 | 0.630 | 0.495 |

Treatment means followed by the same letter subscript are not significantly different. Note - = sample size inadequate for analysis. * = for ryegrass/cocksfoot only.

**Main results late winter – late spring:**

- The mean ADF was 25.1% of DM for grasses and 23.1% of DM for clovers.
- The mean NDF was 44.8 % of DM for grasses and 24.7 % of DM for clovers.
- The mean N% for grasses was 1.8%, 3.1% for subterranean clover and 4.3% for white clover.
- The mean ME was 11.3 MJ/kg DM for grasses, 10.4 MJ/kg DM for subterranean clover (runners present) and 12.1 MJ/kg DM for white clover.

**Appendix 18. Harvested on 20 November 2007 rotation period: 20/8/-20/11/2007 (92 days).**

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Cultivar | ADF | NDF | N% | ME |
| *White clover* | *19.1* | *25.5* | *3.8* | *11.9* |
| *Subterranean clover* | *25.0* | *32.2* | *2.4* | *10.9* |
| 'Revolution' AR1 10 kg/ha | 25.8 $_{b}$ | 49.9 $_{b}$ | 1.6 | 11.6 $_{c}$ |
| 'Revolution' AR1 20 kg/ha | 24.1 $_{c}$ | 46.9 $_{c}$ | 1.6 | 12.2 $_{a}$ |
| 'Revolution' AR1 10 kg/ha & | 24.9 $_{c}$ | 47.5 $_{c}$ | 1.5 | 11.9 $_{b}$ |
| 'Dg25' cocksfoot | - | - | - | - |
| 'Cannon' HE 10 kg/ha | 26.9 $_{a}$ | 51.9 $_{a}$ | 1.5 | 11.2 $_{d}$ |
| 'Samson' AR1 10 kg/ha | 26.7 $_{a}$ | 52.1 $_{a}$ | 1.5 | 11.2 $_{d}$ |
| Mean* | 25.7 | 49.7 | 1.6 | 11.6 |
| SEM* | 0.252 | 0.616 | 0.0421 | 0.050 |
| P value* | <0.001 | <0.001 | 0.249 | <0.001 |

Note - = sample size inadequate for analysis. * = for ryegrass/cocksfoot only.

**Main results late winter – end of spring:**

- ADF (26.8 % of DM) and NDF (52.0% of DM) were higher in 'Cannon HE' and 'Samson AR1' than 'Revolution'.
- Both ADF and NDF were higher in grasses than the clovers (22.1 and 28.9% of DM respectively).
- The mean N% was 1.6% for grasses. This decreased from 1.8% found two weeks earlier (Appendix 17).
- The mean N was 3.8% for white clover and 2.4% for subterranean clover (runners present).
- The ME was higher for 'Revolution' (12.2 MJ/kg DM) than 'Cannon and 'Samson' (11.2 MJ/kg DM).

**Appendix 19. Harvested on 8 April 2008 rotation period: 17/1/-8/4/2008 (82 days).**

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Cultivar | ADF | NDF | N% | ME |
| *White clover* | *19.6* | *24.7* | *2.8* | *11.3* |
| *Subterranean clover* | - | - | - | - |
| 'Revolution' AR1 10 kg/ha | 20.9 | 42.8 | 1.6 | 12.2 |
| 'Revolution' AR1 20 kg/ha | 19.6 | 44.8 | 1.8 | 12.9 |
| 'Revolution' AR1 10 kg/ha & | 20.2 | 45.6 | 1.8 | 12.8 |
| 'Dg25' cocksfoot | 25.4 | 48.3 | 1.3 | 11.2 |
| 'Cannon' HE 10 kg/ha | 21.0 | 41.3 | 2.4 | 11.8 |
| 'Samson' AR1 10 kg/ha | 19.9 | 43.8 | 1.8 | 12.6 |
| Mean* | 21.2 | 44.4 | 1.8 | 12.3 |
| SEM* | 1.39 | 2.47 | 0.34 | 0.39 |
| P value* | 0.120 | 0.494 | 0.397 | 0.69 |

Note - = sample size inadequate for analysis. * = for ryegrass/cocksfoot only

**Main results mid summer – early autumn:**

- The mean ADF was 21.2% of DM and NDF was 44.4% of DM for grasses, while ADF was 19.6% of DM for white clover and NDF was 24.7% of DM.
- The mean N for grasses was 1.8% and 2.8% for white clover.
- The mean ME was 12.3 MJ/kg DM for grasses and 11.3 MJ/kg DM for white clover.

**Appendix 20. Harvested on 2 July 2008 rotation period: 12/4/-2/7/2008 (81 days).**

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Cultivar | ADF | NDF | N | ME |
| *White clover* | - | - | - | - |
| *Subterranean clover* | - | - | - | - |
| 'Revolution' AR1 10 kg/ha | 18.8 | 42.7 | 2.5 | 12.6 $_{bc}$ |
| 'Revolution' AR1 20 kg/ha | 18.6 | 41.1 | 2.7 | 12.8 $_{a}$ |
| 'Revolution' AR1 10 kg/ha & | 18.7 | 42.3 | 2.2 | 12.5 $_{c}$ |
| 'Dg25' cocksfoot | - | - | - | - |
| 'Cannon' HE 10 kg/ha | 18.4 | 41.5 | 2.3 | 12.6 $_{bc}$ |
| 'Samson' AR1 10 kg/ha | 18.9 | 43.9 | 2.0 | 12.8 $_{ab}$ |
| Mean* | 18.7 | 42.3 | 2.3 | 12.7 |
| SEM* | 0.42 | 0.58 | 0.234 | 0.054 |
| P value* | 0.905 | 0.055 | 0.291 | 0.027 |

Note - = sample size inadequate for analysis. * = for ryegrass/cocksfoot only.

**Main results early autumn – mid winter:**

- No differences in most nutritive values due to it being mid winter with only 360 kg DM/ha of sown grass produced (Appendix 28; Botanical composition).
- ME was higher in 'Revolution' 20 kg/ha and lowest in 'Revolution' 10 kg/ha mixed with cocksfoot.
- Insufficient clover or cocksfoot yield for NIRS. Also the 28$^{th}$ of July 2008 harvest data not presented due to insufficient sample for NIRS.

## Year 3

**Appendix 21. Harvested on 10 September 2008 rotation period: 12/4/-10/9/2008 (151 days).**

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Cultivar | ADF | NDF | N | ME |
| *White clover* | *19.7* | *17.9* | *3.6* | *10.2* |
| *Subterranean clover* | - | - | - | - |
| 'Revolution' AR1 10 kg/ha | 21.4 $_{ab}$ | 45.6 $_{b}$ | 2.8 $_{b}$ | 12.0 |
| 'Revolution' AR1 20 kg/ha | 22.3 $_{a}$ | 47.2 $_{a}$ | 2.7 $_{b}$ | 11.8 |
| 'Revolution' AR1 10 kg/ha & | 21.3 $_{ab}$ | 45.1 $_{b}$ | 2.7 $_{b}$ | 12.2 |
| 'Dg25' cocksfoot | - | - | - | - |
| 'Cannon' HE 10 kg/ha | 20.6 $_{c}$ | 44.4 $_{b}$ | 3.4 $_{a}$ | 11.8 |
| 'Samson' AR1 10 kg/ha | 21.3 $_{bc}$ | 45.7 $_{b}$ | 3.0 $_{b}$ | 11.8 |
| Mean* | 21.4 | 45.6 | 2.9 | 11.9 |
| SEM* | 0.28 | 0.48 | 0.14 | 0.13 |
| P value* | 0.037 | 0.029 | 0.029 | 0.181 |

Treatment means followed by the same letter subscript are not significantly different.
Note - = sample size inadequate for analysis. * = for ryegrass/cocksfoot only.

**Main results early autumn – early spring:**

- The highest NDF (47.2% of DM) was from 20 kg/ha of sown 'Revolution'.
- 'Cannon HE' had the highest N of all the grasses at 3.4%. White clover N was 3.6%.
- The mean ME was 11.9 MJ/kg DM for grasses and 10.2 MJ/kg DM for white clover.
- 'Leura' subterranean clover failed to regenerate in any of these treatments.

**Appendix 22. Harvested on 21 October 2008 rotation period: 12/9/-21/10/2008 (39 days).**

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Cultivar | ADF | NDF | N | ME |
| *White clover* | *17.7* | *22.1$_{b}$* | *4.2* | *12.3* |
| *Subterranean clover* | - | - | - | - |
| 'Revolution' AR1 10 kg/ha | 22.3 $_{b}$ | 43.9 $_{b}$ | 1.8 $_{b}$ | 12.5 $_{ab}$ |
| 'Revolution' AR1 20 kg/ha | 22.1 $_{b}$ | 43.2 $_{b}$ | 1.7 $_{b}$ | 12.6 $_{a}$ |
| 'Revolution' AR1 10 kg/ha & | 22.9 $_{b}$ | 45.2 $_{b}$ | 1.7 $_{b}$ | 12.3 $_{ab}$ |
| 'Dg25' cocksfoot | 25.9 $_{a}$ | 53.3 $_{a}$ | 2.2 $_{a}$ | 11.4 $_{c}$ |
| 'Cannon' HE 10 kg/ha | 23.0 $_{b}$ | 45.1 $_{b}$ | 1.7 $_{b}$ | 12.1 $_{b}$ |
| 'Samson' AR1 10 kg/ha | 22.3 $_{b}$ | 44.4 $_{b}$ | 1.8 $_{b}$ | 12.3 $_{ab}$ |
| Mean* | 23.1 | 45.8 | 1.8 | 12.2 |
| SEM* | 0.46 | 0.82 | 0.09 | 0.12 |
| P value* | 0.001 | <0.001 | 0.025 | <0.001 |

Treatment means followed by the same letter subscript are not significantly different.
Note - = sample size inadequate for analysis. * = for ryegrass/cocksfoot only.

**Main results early spring – mid spring:**

- Cocksfoot had the highest ADF (25.9% of DM), NDF (53.3% of DM) and N (2.2%) and lowest ME of 11.4 MJ/kg DM of all the grasses.
- The mean N for grasses was declined to 1.8% compared with 4.2% for white clover.

Note: 22 January 2009 harvest not presented due to insufficient sample for NIRS.

**Appendix 23. Harvested on 19 March 2009 rotation period: (29/1/-19/3/2009) (49 days).**

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Cultivar | ADF | NDF | N | ME |
| *White clover* | *18.0* | *22.6* | *4.2* | *12.1* |
| *Subterranean clover* | - | - | - | - |
| 'Revolution' AR1 10 kg/ha | 19.7 $_{c}$ | 39.1 $_{c}$ | 3.0 | 12.6 $_{ab}$ |
| 'Revolution' AR1 20 kg/ha | 19.9 $_{c}$ | 38.7 $_{c}$ | 2.4 | 12.7 $_{a}$ |
| 'Revolution' AR1 10 kg/ha & | 21.1 $_{bc}$ | 40.6 $_{bc}$ | 2.6 | 12.4 $_{bc}$ |
| 'Dg25' cocksfoot | 24.7 $_{a}$ | 49.6 $_{a}$ | 2.9 | 11.5 $_{e}$ |
| 'Cannon' HE 10 kg/ha | 21.8 $_{b}$ | 42.3 $_{b}$ | 2.8 | 12.2 $_{d}$ |
| 'Samson' AR1 10 kg/ha | 20.7 $_{bc}$ | 40.2 $_{bc}$ | 2.6 | 12.4 $_{cd}$ |
| Mean* | 21.3 | 41.7 | 2.7 | 12.9 |
| SEM* | 0.46 | 0.79 | 0.14 | 0.06 |
| P value* | <0.001 | <0.001 | 0.104 | <0.001 |

Treatment means followed by the same letter subscript are not significantly different.
Note - = sample size inadequate for analysis. * = for ryegrass/cocksfoot only.

**Main results mid summer – early autumn:**

- Cocksfoot had the highest ADF (24.7% of DM) and NDF (49.6% of DM).
- The mean ADF was 18.0% of DM for white clover and NDF was 22.6% of DM.
- The mean N for grasses was 2.7% compared with 4.2% for white clover.
- The ME of 11.5 MJ/kg DM for cocksfoot was lower than all ryegrasses.

**Appendix 24. Harvested on 30 April 2009 rotation period: 29/1/-30/4/2009 (91 days).**

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Cultivar | ADF | NDF | N | ME |
| *White clover* | - | - | - | - |
| *Subterranean clover* | - | - | - | - |
| 'Revolution' AR1 10 kg/ha | 19.1 $_{b}$ | 40.6$_{c}$ | 2.0 $_{c}$ | 12.8 $_{a}$ |
| 'Revolution' AR1 20 kg/ha | 21.6 $_{ab}$ | 47.4 $_{ab}$ | 2.4 $_{ab}$ | 11.9 $_{bc}$ |
| 'Revolution' AR1 10 kg/ha & | 19.2 $_{b}$ | 41.9 $_{c}$ | 2.2 $_{bc}$ | 12.7 $_{a}$ |
| 'Dg25' cocksfoot | 22.9 $_{a}$ | 50.1 $_{a}$ | 2.6 $_{a}$ | 11.7 $_{c}$ |
| 'Cannon' HE 10 kg/ha | 20.1 $_{b}$ | 42.6 $_{bc}$ | 2.2 $_{bc}$ | 12.3 $_{ab}$ |
| 'Samson' AR1 10 kg/ha | 19.4 $_{b}$ | 41.7 $_{c}$ | 2.1 $_{bc}$ | 12.6 $_{ab}$ |
| Mean* | 20.4 | 44.1 | 2.3 | 12.3 |
| SEM* | 0.81 | 1.64 | 0.10 | 0.21 |
| P value* | 0.04 | 0.012 | 0.22 | 0.019 |

Treatment means followed by the same letter subscript are not significantly different.
Note - = sample size inadequate for analysis. * = for ryegrass/cocksfoot only.

**Main results mid summer – late autumn:**

- ADF of 22.9% DM for cocksfoot was higher than the ryegrasses.
- Cocksfoot also had the highest NDF (50% of DM) and N (2.6%), but had the lowest ME (11.7 MJ/kg DM).
- 'Revolution' sown at 10 kg/ha had lower NDF and higher ME than when sown at 20 kg/ha.

## *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.

### Year 1

**Appendix 25. Harvested on 18 July 2007 rotation period: -30/1/-18/7/2007 (169 days).**

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Cultivar/Species | ADF | NDF | N | ME |
| *White clover* | *18.5* | *23.0* | *3.4* | *11.7* |
| *Subterranean clover* | *20.9* | *25.2* | *3.1* | *11.0* |
| 'Advance' Tall fescue | 21.1 $_{ab}$ | 42.4 $_{b}$ | 2.4 $_{b}$ | 11.7 $_{bc}$ |
| 'Advance' Tf +endophyte | 20.6 $_{abc}$ | 41.7 $_{b}$ | 2.4 $_{b}$ | 11.8 $_{ab}$ |
| Agriseeds 'Dg25' Cf | 18.7 $_{c}$ | 41.6 $_{b}$ | 3.4 $_{a}$ | 12.0 $_{a}$ |
| 'Ella' cocksfoot | 22.5 $_{a}$ | 46.8 $_{a}$ | 3.0 $_{a}$ | 11.5 $_{bc}$ |
| 'Bareno' brome | 19.9 $_{bc}$ | 42.6 $_{b}$ | 3.1 $_{a}$ | 11.4 $_{c}$ |
| Mean* | 20.5 | 43.0 | 2.8 | 11.7 |
| SEM* | 0.67 | 1.02 | 0.15 | 0.08 |
| P value* | 0.034 | 0.035 | 0.006 | 0.005 |

Treatment means followed by the same letter subscript are not significantly different.
Note - = sample size inadequate for analysis. * = for grasses only.

**Main results sowing – mid winter:**

- 'Ella' cocksfoot had higher ADF (22.5% of DM) and higher NDF (46.8% of DM) than all other grasses.
- N% of tall fescue was lower than other grasses.
- ME ranged from 11.4 ('Bareno') to 12 MJ/kg DM ('Dg25' cocksfoot).
- The clovers ADF was ~19.7% of DM and NDF was ~24.0% of DM compared with 43.0% of DM for the grasses.

## Year 2

**Appendix 26. Harvested on 5 November 2007 rotation period: 20/8/-5/11/2007 (77 days).**

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Cultivar/Species | ADF | NDF | N | ME |
| *White clover* | *18.5* | *23.7* | *4.6* | *12.1* |
| *Subterranean clover* | *21.2* | *27.3* | *3.6* | *11.2* |
| 'Advance' Tall fescue | 25.9 | 45.7 | 3.0 | 10.8 |
| 'Advance' Tf +endophyte | 26.7 | 52.3 | 2.5 | 10.6 |
| Agriseeds 'Dg25' Cf | 27.0 | 53.6 | 3.0 | 10.9 |
| 'Ella' cocksfoot | 27.0 | 53.6 | 3.0 | 10.9 |
| 'Bareno' brome | 23.0 | 35.9 | 3.4 | 11.2 |
| Mean* | 25.9 | 48.2 | 3.0 | 10.9 |
| SEM* | 1.11 | 5.01 | 0.19 | 0.17 |
| P value* | 0.152 | 0.143 | 0.076 | 0.213 |

Note - = sample size inadequate for analysis. * = for grasses only.

**Main results late winter – mid spring:**

- The mean ADF for grasses was 25.9% of DM and NDF was 48.2% of DM.
- Grass N averaged 3.0% compared with 4.6% for white clover and 3.6% for subterranean clover.
- The mean ME was 10.9 MJ/kg DM for grasses and 11.7 MJ/kg DM for clovers.

**Appendix 27. Harvested on 20 November 2007 rotation period: 20/8/-20/11/2007 (92 days).**

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Cultivar/Species | ADF | NDF | N | ME |
| *White clover* | *18.6* | *23.5* | *4.1* | *12.3* |
| *Subterranean clover* | *23.2* | *30.3* | *2.6* | *11.4* |
| 'Advance' Tall fescue | 26.5 | 51.7 | 2.0 | 10.9 |
| 'Advance' Tf +endophyte | 25.4 | 51.2 | 2.1 | 11.3 |
| Agriseeds 'Dg25' Cf | 27.2 | 54.0 | 2.3 | 11.2 |
| 'Ella' cocksfoot | 27.6 | 54.1 | 2.5 | 11.0 |
| 'Bareno' brome | 28.3 | 56.4 | 2.3 | 10.7 |
| Mean* | 27.0 | 53.5 | 2.2 | 11.0 |
| SEM* | 0.85 | 1.09 | 0.10 | 0.15 |
| P value* | 0.237 | 0.055 | 0.052 | 0.131 |

Note - = sample size inadequate for analysis. * = for grasses only.

**Main results late winter – end of spring:**

- Mean ADF was 27.0% of DM for grasses, and ~20.9% of DM for clovers.
- Mean NDF was 53.5% of DM for grasses, 23.5% of DM for white clover and 30.3% of DM for subterranean clover.
- N was 2.2% for grasses, 2.6% for subterranean clover (runners present) and 4.1% for white clover.
- Mean ME was 11.0 MJ/kg DM for grasses, 12.3 MJ/kg DM for white clover and 11.4 MJ/kg DM for subterranean clover.
- Ryegrass mixtures has a lower NDF (49.7% of DM) and higher ME (11.6 MJ/kg DM) (Appendix 18) than these dryland mixtures for the same regrowth period.

**Appendix 28. Harvested on 8 April 2008 rotation period: 17/1/-8/4/2008 (82 days).**

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Cultivar/Species | ADF | NDF | N | ME |
| *White clover* | *18.3* | *24.4* | *3.5* | *11.8* |
| *Subterranean clover* | - | - | - | - |
| 'Advance' Tall fescue | 18.2 $_{c}$ | 43.3 $_{b}$ | 2.2 $_{b}$ | 12.3 $_{a}$ |
| 'Advance' Tf +endophyte | 17.7 $_{c}$ | 43.3 $_{b}$ | 2.3 $_{b}$ | 12.3 $_{a}$ |
| Agriseeds 'Dg25' Cf | 23.4 $_{b}$ | 53.0 $_{a}$ | 2.2 $_{b}$ | 11.7 $_{b}$ |
| 'Ella' cocksfoot | 26.2 $_{a}$ | 56.2 $_{a}$ | 2.3 $_{b}$ | 11.3 $_{b}$ |
| 'Bareno' brome | 23.4 $_{b}$ | 53.7 $_{a}$ | 2.9 $_{a}$ | 11.4 $_{b}$ |
| Mean* | 21.8 | 49.9 | 2.4 | 11.8 |
| SEM* | 0.63 | 0.97 | 0.11 | 0.15 |
| P value* | <0.001 | <0.001 | 0.008 | 0.004 |

Treatment means followed by the same letter subscript are not significantly different.
Note - = sample size inadequate for analysis. * = for grasses only.

**Main results mid summer – early autumn:**

- 'Ella' cocksfoot had the highest ADF (26.2% of DM).
- Both cocksfoots and 'Bareno' had higher NDF (54.3% DM) than tall fescue.
- N for 'Bareno' (2.9%) was higher than for all other grasses.
- The mean N for white clover was 3.5%
- Both tall fescues had a higher ME of 12.3 MJ/kg DM than other grasses.

**Appendix 29. Harvested on 2 July 2008 rotation period: 12/4/-2/7/2008 (81 days).**

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Cultivar/Species | ADF | NDF | N | ME |
| *White clover* | *19.1* | *21.0* | *3.8* | *11.2* |
| *Subterranean clover* | - | - | - | - |
| 'Advance' Tall fescue | 19.4 | 45.0 | 3.1 | 11.7 |
| 'Advance' Tf +endophyte | 18.7 | 35.3 | 2.8 | 11.3 |
| Agriseeds 'Dg25' Cf | 22.7 | 47.4 | 2.7 | 11.4 |
| 'Ella' cocksfoot | 22.0 | 43.1 | 3.0 | 11.9 |
| 'Bareno' brome | 21.2 | 48.4 | 2.6 | 11.5 |
| Mean* | 20.8 | 43.8 | 2.8 | 11.6 |
| SEM* | 1.23 | 3.48 | 0.56 | 0.44 |
| P value* | 0.200 | 0.146 | 0.956 | 0.831 |

Note - = sample size inadequate for analysis. * = for grasses only.

**Main results early autumn – mid winter:**

- Measurement taken mid winter when there was little yield (340 kg DM/ha for sown grasses, Appendix 41, Botanical composition), showed no difference in nutritive values.

Note: 28 July 2008 harvest not presented due to insufficient sample for NIRS.

## Year 3

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

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Cultivar/Species | ADF | NDF | N | ME |
| *White clover* | *17.3* | *20.0* | *4.5* | *11.9* |
| *Subterranean clover* | - | - | - | - |
| 'Advance' Tall fescue | 20.0 $_{c}$ | 43.6 $_{c}$ | 3.8 $_{b}$ | 11.6 $_{b}$ |
| 'Advance' Tf +endophyte | 19.4 $_{c}$ | 42.3 $_{c}$ | 3.6 $_{b}$ | 12.0 $_{a}$ |
| Agriseeds 'Dg25' Cf | 23.2 $_{ab}$ | 51.8 $_{a}$ | 3.8 $_{b}$ | 11.5 $_{bc}$ |
| 'Ella' cocksfoot | 22.5 $_{b}$ | 47.7 $_{b}$ | 4.5 $_{a}$ | 11.5 $_{bc}$ |
| 'Bareno' brome | 24.3 $_{a}$ | 51.8 $_{a}$ | 3.6 $_{b}$ | 11.2 $_{c}$ |
| Mean* | 21.9 | 47.4 | 3.8 | 11.6 |
| SEM* | 0.44 | 0.79 | 0.12 | 0.11 |
| P value* | <0.001 | <0.001 | 0.011 | 0.005 |

Treatment means followed by the same letter subscript are not significantly different.
Note - = sample size inadequate for analysis. * = for grasses only.

**Main results mid autumn – early spring:**

- 'Bareno' had the highest ADF (24.3% of DM) and tall fescue had the lowest (~19.7% of DM).
- 'Bareno' and 'Dg 25' cocksfoot had higher NDF (51.8% of DM) than tall fescue and 'Ella' cocksfoot. This may have been due to their higher yields of 1.5 t DM/ha (Appendix 43; Botanical composition).
- N for 'Ella' cocksfoot and white clover was 4.5% and was higher than other grasses.
- The ME ranged from 11.2 ('Bareno') to 12 MJ/kg DM (tall fescue with endophyte).
- 'Leura' Subterranean clover failed to regenerate in any of these treatments.

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

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Cultivar/Species | ADF | NDF | N | ME |
| *White clover* | *17.4* | *21.9* | *4.2* | *12.4* |
| *Subterranean clover* | - | - | - | - |
| 'Advance' Tall fescue | 22.1 $_{b}$ | 47.0 $_{b}$ | 2.3 | 11.8 $_{a}$ |
| 'Advance' Tf +endophyte | 21.6 $_{b}$ | 45.8 $_{b}$ | 2.2 | 12.0 $_{a}$ |
| Agriseeds 'Dg25' Cf | 26.3 $_{a}$ | 54.5 $_{a}$ | 2.3 | 11.4 $_{b}$ |
| 'Ella' cocksfoot | 26.9 $_{a}$ | 53.3 $_{a}$ | 2.5 | 11.3 $_{b}$ |
| 'Bareno' brome | 27.2 $_{a}$ | 55.7 $_{a}$ | 2.7 | 11.1 $_{c}$ |
| Mean* | 24.8 | 51.3 | 2.4 | 11.5 |
| SEM* | 0.41 | 1.15 | 0.11 | 0.07 |
| P value* | <0.001 | <0.001 | 0.063 | <0.001 |

Treatment means followed by the same letter subscript are not significantly different.
Note - = sample size inadequate for analysis. * = for grasses only.

**Main results early spring – mid spring:**

- Both tall fescues had the lower ADF (21.9% of DM) and NDF (46.4% of DM), but higher ME (11.9 MJ/kg DM) than other grasses.
- The mean N was 2.4% for grasses and 4.2% for white clover.
- ME of 'Bareno' (11.1 MJ/kg DM) was lower than other grasses and tall fescue (~11.6 MJ/kg DM).
- Grass in the ryegrass mixtures has a lower NDF (45.8% of DM) and N (1.8%) but a higher ME (12.2 MJ/kg DM) (Appendix 22) compared with these dryland mixtures.

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

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Cultivar/Species | ADF | NDF | N | ME |
| *White clover* | *20.8* | *28.7* | *3.4* | *11.4* |
| *Subterranean clover* | - | - | - | - |
| 'Advance' Tall fescue | 23.8 $_{c}$ | 50.7 $_{c}$ | 2.4 | 11.4 $_{a}$ |
| 'Advance' Tf +endophyte | 22.9 $_{c}$ | 49.2 $_{c}$ | 2.5 | 11.4 $_{a}$ |
| Agriseeds 'Dg25' Cf | 28.7 $_{ab}$ | 58.6 $_{ab}$ | 2.4 | 10.9 $_{b}$ |
| 'Ella' cocksfoot | 28.5 $_{b}$ | 57.8 $_{b}$ | 2.8 | 10.8 $_{b}$ |
| 'Bareno' brome | 30.4 $_{a}$ | 61.8 $_{a}$ | 2.5 | 10.3 $_{c}$ |
| Mean* | 26.8 | 55.6 | 2.5 | 11.0 |
| SEM* | 0.50 | 1.11 | 0.09 | 0.10 |
| P value* | <0.001 | <0.001 | 0.059 | <0.001 |

Treatment means followed by the same letter subscript are not significantly different.
Note - = sample size inadequate for analysis. * = for grasses only.

**Main results mid spring – mid summer:**

- Similar to 22 October 2008 (Appendix 31) tall fescue had the lowest ADF (23.4% of DM) and NDF (50.0% of DM) and 'Bareno' had the highest.
- The mean N was 2.5% for grasses and 3.4% for white clover.
- Tall fescue ME was similar to white clover (11.4 MJ/kg DM) and higher than the other grasses.

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

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Cultivar/Species | ADF | NDF | N | ME |
| *White clover* | *16.6* | *24.6* | *4.6* | *12.1* |
| *Subterranean clover* | - | - | - | - |
| 'Advance' Tall fescue | 19.3 $_{b}$ | 44.3 $_{b}$ | 3.4 | 11.9 $_{a}$ |
| 'Advance' Tf +endophyte | 18.5 $_{b}$ | 42.2 $_{b}$ | 3.1 | 12.3 $_{a}$ |
| Agriseeds 'Dg25' Cf | 27.0 $_{a}$ | 55.9 $_{a}$ | 3.0 | 11.2 $_{b}$ |
| 'Ella' cocksfoot | 25.8 $_{a}$ | 52.6 $_{a}$ | 3.4 | 11.2 $_{b}$ |
| 'Bareno' brome | 25.7 $_{a}$ | 54.1 $_{a}$ | 3.3 | 11.0 $_{b}$ |
| Mean* | 23.3 | 49.8 | 3.3 | 11.5 |
| SEM* | 0.77 | 1.08 | 0.59 | 0.15 |
| P value* | <0.001 | <0.001 | 0.550 | 0.001 |

Treatment means followed by the same letter subscript are not significantly different.
Note - = sample size inadequate for analysis. * = for grasses only.

**Main results mid summer – late summer:**

- March 2009 follows a similar trend to October 2008(Appendix 31) and January 2009 (Appendix 32).
- Tall fescue had lower ADF (18.9% of DM) and NDF (43.3% of DM) but higher ME (12.1 MJ/kg DM) than other grasses.
- The mean N was 3.3% for grasses and 4.6% for white clover.
- The ME for tall fescue (12.1 MJ/kg DM) was similar to white clover and higher than the other grasses.

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

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Cultivar/Species | ADF | NDF | N | ME |
| *White clover* | *17.7* | *27.6* | *4.3* | *10.5* |
| *Subterranean clover* | - | - | - | - |
| 'Advance' Tall fescue | 18.0 $_{c}$ | 45.6 $_{c}$ | 2.4 | 11.5 $_{a}$ |
| 'Advance' Tf +endophyte | 20.3 $_{b}$ | 49.2 $_{b}$ | 2.8 | 11.3 $_{ab}$ |
| Agriseeds 'Dg25' Cf | 25.0 $_{a}$ | 57.2 $_{a}$ | 2.7 | 11.1 $_{ab}$ |
| 'Ella' cocksfoot | 26.6 $_{a}$ | 57.7 $_{a}$ | 2.6 | 10.7 $_{bc}$ |
| 'Bareno' brome | 26.1 $_{a}$ | 58.7 $_{a}$ | 2.9 | 10.1 $_{c}$ |
| Mean* | 23.2 | 53.7 | 2.7 | 11.0 |
| SEM* | 0.50 | 0.93 | 0.17 | 0.22 |
| P value* | <0.001 | <0.001 | 0.241 | 0.013 |

Treatment means followed by the same letter subscript are not significantly different.
Note - = sample size inadequate for analysis. * = for grasses only.

**Main results mid summer – late autumn:**

- ADF ranged from 18.0 (tall fescue) to 26.6% of DM ('Ella' cocksfoot).
- The NDF was higher in 'Bareno' and both cocksfoots (57.9% of DM) than tall fescue.
- The mean for N was 2.7% for grasses and 4.3% for white clover.
- The mean ME of tall fescue (11.5 MJ/kg DM) was higher than 'Bareno' (10.1 MJ/kg DM).

## *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.
- Treatments include:
  'Kahu' timothy
  'Kahu' timothy and chicory
  'Kahu' timothy and plantain
  'Kahu' timothy, chicory and plantain
  'Kahu' timothy and red clover
- Individual species means presented only. Chicory and Plantain values are from two treatments (i.e. 'Kahu' timothy and **chicory** and 'Kahu' timothy, with **chicory** and plantain).

### Year 1

**Appendix 35. Harvested on 18 July 2007 rotation period: 30/1/-18/7/2007 (169 days).**

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Species | ADF | NDF | N | ME |
| Timothy | 14.9 | 31.1 | 3.4 | 12.7 |
| White clover | 17.3 | 24.3 | 3.7 | 11.4 |
| Subterranean clover | 19.6 | 25.9 | 3.3 | 10.5 |
| Red clover | 21.1 | 30.3 | 3.0 | 9.9 |
| Chicory | 15.0 | 22.3 | 2.8 | 11.7 |
| Plantain | 17.2 | 29.4 | 2.7 | 10.7 |

Note: Due to insufficient sample size nutritive samples were bulked across replicates. Consequently, data was unable to be statistically analysed.

**Main results sowing – mid winter:**

- ADF ranged from 15.0 (chicory) to 21.1% of DM (red clover).
- NDF ranged from 22.3 (chicory) to 31.1% of DM (timothy).
- N ranged from 2.7 (plantain) to 3.7% (white clover).
- ME ranged from 9.9 (red clover) to 12.7 MJ/kg DM (timothy).

## Year 2

**Appendix 36. Harvested on 5 November 2007 rotation period: 20/8/-5/11/2007 (77 days).**

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Species | ADF | NDF | N | ME |
| Timothy | 24.6 | 45.1 | 2.5 | 11.0 |
| White clover | 17.9 | 24.2 | 4.6 | 12.2 |
| Subterranean clover | 21.2 | 28.2 | 3.4 | 11.2 |
| Red clover | 21.5 | 24.8 | 3.2 | 11.3 |
| Chicory | - | - | - | - |
| Plantain | 20.6 | 31.3 | 2.8 | 11.0 |

Note: Due to insufficient sample size nutritive samples were bulked across replicates. Consequently, data was unable to be statistically analysed. - = insufficient sample for NIRS.

**Main results mid winter – mid spring:**

- ADF ranged from 17.9 (white clover) to 24.6% of DM (timothy).
- NDF ranged from 24.2 (white clover) to 45.1% of DM (timothy).
- N ranged from 2.5 (timothy) to 4.6% (white clover).
- ME ranged from 11.0 (timothy and plantain) to 12.2 MJ/kg DM (white clover).

**Appendix 37. Harvested on 20 November 2007 rotation period: 20/8/-20/11/2007 (92 days).**

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Species | ADF | NDF | N% | ME |
| Timothy | 23.6 | 43.9 | 2.1 | 11.7 |
| White clover | 18.8 | 23.6 | 3.9 | 12.3 |
| Subterranean clover | 22.3 | 28.8 | 2.9 | 11.7 |
| Red clover | 21.5 | 28.5 | 3.6 | 10.5 |
| Chicory | 19.0 | 24.7 | 2.4 | 12.0 |
| Plantain | 22.0 | 30.8 | 2.0 | 11.3 |

Note: Due to insufficient sample size nutritive samples were bulked across replicates. Consequently, data was unable to be statistically analysed.

**Main results mid winter – late spring:**

- ADF ranged from 18.8 (white clover) to 23.6 % of DM (timothy).
- NDF ranged from 23.6 (white clover) to 43.9% of DM (timothy).
- N ranged from 2.0 (plantain) to 3.9% (white clover).
- ME ranged from 10.5 (red clover) to 12.3 MJ/kg DM (white clover).
- Timothy NDF (43.9% DM) was lower than grasses in ryegrass mixtures (49.7% DM; Appendix 19). Its N was higher (2.1 and 1.6% respectively), while the ME was similar (11.7 and 11.6 MJ/kg DM respectively).

**Appendix 38. Harvested on 8 April 2008 rotation period: 1/12/2007-8/4/2008 (129 days).**

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Species | ADF | NDF | N | ME |
| Timothy | 19.1 | 28.4 | 3.1 | 12.1 |
| White clover | 17.9 | 24.0 | 3.4 | 12.0 |
| Subterranean clover | - | - | - | - |
| Red clover | 18.9 | 27.4 | 3.2 | 10.9 |
| Chicory | 17.7 | 24.9 | 2.7 | 11.7 |
| Plantain | 19.6 | 31.9 | 2.2 | 11.2 |

Note: Due to insufficient sample size nutritive samples were bulked across replicates. Consequently, data was unable to be statistically analysed. - = insufficient sample for NIRS.

**Main results early summer – early autumn:**

- ADF ranged from 17.7 (chicory) to 19.6% of DM (plantain).
- NDF ranged from 24.0 (white clover) to 31.9 % of DM (plantain).
- N ranged from 2.2 (plantain) to 3.4% (white clover).
- ME ranged from 10.9 (red clover) to 12.1 MJ/kg DM (timothy).
- Timothy NDF (28.4% of DM) was lower than ryegrass (44.4% of DM; Appendix 19) and dryland grasses (49.9% of DM; Appendix 28).Timothy N (3.1%) was higher than ryegrasses (1.8%) and dryland grasses (2.4%) but its ME (12.1 MJ/kg DM) was lower than ryegrasses (12.3 MJ/kg DM) and higher than dryland grasses (11.8 MJ/kg DM).

## Year 3

**Appendix 39. Harvested on 21 October 2008 rotation period: 12/4/-21/10/2008 (192 days).**

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Species | ADF | NDF | N | ME |
| Timothy | 22.2 | 40.4 | 1.9 | 11.9 |
| White clover | 17.3 | 22.1 | 4.2 | 12.3 |
| Subterranean clover | - | - | - | - |
| Red clover | 20.7 | 27.1 | 3.6 | 11.0 |
| Chicory | 18.4 | 23.1 | 2.9 | 11.8 |
| Plantain | 17.9 | 28.1 | 2.7 | 11.8 |

Note: Due to insufficient sample size nutritive samples were bulked across replicates. Consequently, data was unable to be statistically analysed. - = insufficient sample for NIRS.

**Main results early autumn – mid spring:**

- ADF ranged from 17.3 (white clover) to 22.2% of DM (timothy).
- NDF ranged from 22.1 (white clover) to 40.4% of DM (timothy).
- N ranged from 1.9 (timothy) to 4.2% (white clover).
- ME ranged from 11.0 (red clover) to 12.3 MJ/kg DM (white clover).
- Timothy NDF was lower than grasses in both ryegrass (45.8% of DM; Appendix 23) and dryland mixtures (51.3% of DM; Appendix 32). The N for timothy and ryegrass mixtures (1.9%) was lower than dryland grasses (2.4%). The ME was similar for all (11.9 MJ/kg DM).
- 'Leura' subterranean clover failed to regenerate.

Note: 22 January 2009 there was insufficient sample for NIRS.

**Appendix 40. Harvested on 19 March 2009 rotation period: 29/1/-19/3/2009 (49 days).**

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Species | ADF | NDF | N | ME |
| Timothy (n=3) | 20.8 | 41.7 | 3.8 | 11.9 |
| White clover | 17.6 | 27.4 | 4.4 | 11.8 |
| Subterranean clover | - | - | - | - |
| Red clover | - | - | - | - |
| Chicory | 18.2 | 17.1 | 3.3 | 11.1 |
| Plantain | 18.9 | 33.4 | 2.8 | 10.8 |

Note: Due to insufficient sample size nutritive samples were bulked across replicates. Consequently, data was unable to be statistically analysed. - = insufficient sample for NIRS.

**Main results mid summer – late autumn:**

- ADF ranged from 17.6 (white clover) to 20.8% of DM (timothy)
- NDF ranged from 17.1 (chicory) to 41.7% of DM (timothy).
- N ranged from 2.8 (plantain) to 4.4% (white clover).
- ME ranged from 10.8 (plantain) to 11.9 (timothy).

Note: Timothy represents grass in three treatments as there was no timothy found in the mixtures with plantain. This occurred again on 30th of April 2009 (Appendix 40).

**Appendix 41. Harvested on 30 April 2009 rotation period: 29/1/-30/4/2009 (91 days).**

| | % of Dry Matter | | | MJ/kg DM |
|---|---|---|---|---|
| Species | ADF | NDF | N | ME |
| Timothy (n=3) | 17.7 | 36.7 | 2.7 | 10.5 |
| White clover | 18.8 | 26.9 | 4.3 | 11.0 |
| Subterranean clover | - | - | - | - |
| Red clover | - | - | - | - |
| Chicory | 18.5 | 27.5 | 3.3 | 10.4 |
| Plantain | 20.0 | 32.1 | 2.0 | 11.1 |

Note: Due to insufficient sample size nutritive samples were bulked across replicates. Consequently, data was unable to be statistically analysed. - = insufficient sample for NIRS.

**Main results mid summer – late autumn:**

- ADF ranged from 17.7 (timothy) to 20.0% of DM (plantain).
- NDF ranged from 26.9 (white clover) to 36.7% of DM (timothy).
- N ranged from 2.0 (plantain) to 4.3% (white clover).
- ME ranged from 10.4 (chicory) to 11.1 MJ/kg DM (plantain).
- Timothy NDF (36.7% of DM) was lower than ryegrasses (44.1% of DM; Appendix 24) and dryland grasses (53.7% of DM; Appendix 34). Timothy N (2.7%) was similar to dryland grasses and higher than ryegrasses (2.3%), while its ME was lower (10.5 MJ/kg DM) than ryegrass (12.3 MJ/kg DM) and dryland grasses (11.0 MJ/kg DM).

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