An attempt to define links between pasture constituents and ewe performance

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Introduction

Until very recently in sheep breeding systems the limitation to increasing production has been genetics and feeding. It is arguable in many cases whether feeding has yet been appropriately tailored to meet the demands of the higher performance genetics now present on many farms.

The introduction of exotic genetics (particularly the Finn and East Friesian breeds), plus an increased focus of breeders of traditional sheep on fecundity has resulted in a situation where for many flocks fecundity is no longer a limitation to the number of lambs produced.

This has seen an increased feed demand over the lamb rearing period on many properties.

Improved management of the pasture supply has been the major focus of most attempts to feed these high performing breeding stock better. This includes: Later lambing dates, controlled grazing systems to more accurately allocate feed (especially through winter), use of new pasture cultivars, lifting phosphate levels and using nitrogen to increase pasture supply through the winter and early spring.

Much of the feed on offer at lambing time is freshly grown rather than winter – saved.

However, despite these management changes, capturing the extra fecundity has proved to be elusive. Both lamb survival and lamb growth rates on many farms have declined – despite increasing the feed supply. Of course it has been shown that lamb survival decreases as fecundity increases,[1] but on many farms this has seemed excessive.

For example a number of the farms in this trial have recorded lamb losses of up to 30%, and ewe losses of 10 – 15% over the late winter and lambing period. In the 2004 and 2005 lambing seasons these losses were particularly pronounced.

Increased ewe deaths

The majority of ewe deaths appear to be occurring in the 4 weeks before and around lambing. Bearings are not uncommonly a cause of these deaths, but this is variable according to the season. However the 'non – bearing' ewe deaths are becoming a consistent feature of systems that are producing more grass to supply very fecund flocks.
Feedback from farmers suggests that the cause of death is not obvious where high death rates are occurring in MA ewes. Feedback also indicates that these ewes tend

to be hard to find – if they were dying suddenly they would be seen easily. If they are taking some time to die it is more likely that they will separate from the flock.

A possible sequel to nitrogen use?

The nature of the grass on offer to these flocks has changed considerably from the 'winter - saved' pasture traditionally offered to ewes at lambing time. In the years immediately preceding 2006 a proportion of farmers experiencing these increased losses had adopted the practice of applying fertiliser nitrogen in late winter or up close to lambing to boost the grass supply.

The poor lambing results obtained by many of these farmers in the same years as applying this intervention led many to start questioning whether N application was a cause of these poor results.

The negative effect of lush, nitrogen boosted pasture (as a sole diet) on the rumen function and metabolic status of high performing peri parturient dairy cows is recognised. [2]

Is it possible that a similar negative effect may be operating in these high performing ewe flocks? Or is N use a proxy for other factors that are contributing to increased losses on these farms?

A trial to assess the effect of N use on ewe performance

There is work in New Zealand showing small negative effects of urea boosted pasture on milk production and reproduction in dairy cows.[3,4] Certainly milk fever is not an uncommon disease of multiple bearing ewes when they are suddenly introduced to lush, fast growing new grass (especially annual or short rotation ryegrasses). But there is no work directly applicable to the situation described above.[5]

The aim of this trial was to as far as possible establish/define any links between pasture constituents (with and without N use), ewe metabolic parameters, and lambing/lactational performance, including lamb and ewe losses.

Study Design

Twenty two flocks of above average fecundity were involved in the project, in the lambing season of 2006. These flocks were a mixture of North Island hill country flocks, and three South Island hill country flocks. All farms were properties where the 'basic' procedures that can lift lamb survival e.g. mid pregnancy shearing, trace element supplementation, 5 in 1 vaccination were already being addressed.

There were 1 – 3 'study paddocks' on each farm. Twin bearing mixed age ewes were lambed in these paddocks. Pasture samples were collected from these paddocks and analysed for nutritional and mineral status. The following components were analysed:

- Dry matter (DM)
- Metabolisable energy (ME)
- Crude protein (CP)
- Soluble carbohydrate (Sol CHO)
- Neutral detergent fibre (NDF – a measure of the level of useful dietary fibre)
- Dietary cation:anion difference (DCAD – a ratio of pasture minerals used in dairy systems to assess the level of risk presented by a pasture with respect to metabolic disease in calving cows)
- Sodium (Na)
- Potassium (K)
- Potassium: Sodium ratio (K:Na)

These samples were taken by the farmer, at grazing height, at approximately 10 days to 2 weeks pre – lamb, and again at docking. The samples were refrigerated as soon as practicable after collection and then sent by same – day post to NZ laboratory Services Ltd, Ruakura. The delay between collection and analysis may have negatively affected the level of soluble carbohydrate measured in the samples.

Pasture height per se was not measured.

There was an attempt to create variation between paddocks within and between farms by applying differential rates of N fertiliser. Rates varied from 0 to 76 kg of N, based on what the farmer was willing to apply. The data sets from 19 of the farms were included in this analysis, as three farms had incomplete data for this parameter.

Table 1. Farm/paddock location and rate of N applied.

Farm Code	Napp*	N type	Farm Code	Napp	N type
Alfredton	55	Sustain	Kirikau	30	Sustain
Alfredton	55	Sustain	Kirikau	30	Sustain
Alfredton	60	Sustain	Kirikau	30	Sustain
Arapata	70	Urea	Kiwitea	0	
Dannevirke 1	23	Sustain	Kiwitea	0	
Dannevirke 1	28	Sustain	Kiwitea	0	
Dannevirke 2	50	Urea	Pahiatua	60	Sustain
Dannevirke 2	50	Urea	Pahiatua	60	Sustain
Dannevirke 2	55	Urea	Pahiatua	69	Sustain
Gore 1	0		Taumaranui 1	69	Sustain
Gore 1	30	Urea	Taumaranui 1	76	Sustain
Gore 1	30	Urea	Taumaranui 1	76	Sustain
Gore 6	0		Taumaranui 2	14	Sustain
Gore 6	30	Urea	Taumaranui 2	14	Sustain
Gore 6	55	Urea	Taumaranui 2	28	Sustain
Gore 7	0		Umutoi	46	Sustain
Gore 7	0		Umutoi	46	Sustain
Gore 7	55	Sustain	Umutoi	50	Sustain
Halcombe	0		Utuwai	0	
Halcombe	14	Urea	Utuwai	0	
Halcombe	14	Urea	Utuwai	35	Sustain
Kimbolton 1	0		Waituna West	37	Sustain
Kimbolton 1	37	Urea	Waituna West	38	Sustain
Kimbolton 1	55	Urea	Waituna West	38	Sustain
Kimbolton 2	28	Sustain	Woodville	14	Urea
Kimbolton 2	30	Sustain	Woodville	16	Urea
Kimbolton 2	30	Sustain	Woodville	18	Urea

*Nitrogen application rate

In the original trial design it was not intended that different types of N product be used. 28 Paddocks had Sustain™ applied and 15 paddocks had plain Urea applied.

The productive outcomes from each paddock were measured; namely ewe and lamb death rates, lamb growth rate, and for 1 paddock on each farm, ewe metabolic parameters (see below).

In one paddock on each farm there were 50 individually identified twinning mixed age ewes who lambed in the first few days of lambing. They were identified as such by having been marked by a harnessed ram in the first 72 hours of mating. These ewes were used as body condition score indicators (at scanning (July), pre lamb (August/September), docking (October to early December) and weaning (December/January), plus a sample of them were bled for metabolic status 10 days to two weeks before lambing.

The following metabolic parameters were measured:

a. Serum Calcium
b. Serum Magnesium
c. Liver function panel including: bile acids and gamma glutamyl transferase (GGT – a measure of facial eczema – induced liver damage)
d. Blood urea nitrogen (BUN)

Unlike any previous NZ studies, this sampling occurred at a **known time** relative to when the ewe was going to lamb. Ewes were sampled immediately after removal from pasture.

Results

Effect of N application per se on pasture constituents

When the pasture constituents were compared for differences based simply on ‘N applied’ versus ‘N not applied’, using a simple ANOVA, there were no significant differences for any of the pasture components, either at pre – lamb or at docking. See tables 2 and 3 below.

Table 2. Mean values for pasture constituents of pre lamb sample (24th August – 6th October)

Napp	DM1	ME	CP	SolCarb	NDF	DCAD	K	Na	K:Na
N	18.6	11.9	24.9	12	44.4	385	3.17	0.155	29.3
Y	18.4	11.7	26.3	10.7	47	391	3.1	0.165	27.5

Table 3. Mean values for pasture constituents of docking sample (18th October – 12th December)

Napp	DM2	ME2	CP2	SolCarb2	NDF2	DCAD2	K2	Na2	K:Na2
N	18.9	11.7	20.3	13.7	49.5	352	2.91	0.140	27.9
Y	18.1	11.9	23.3	12.7	47.2	326	2.77	0.174	23.3

Effect of rate of N application on pasture components

When all paddocks were included in a linear regression analysis, rate of N application had no significant effect on any of the pasture components. There were significant differences between all farms for all pasture components at both sampling periods, except for dry matter (DM) and neutral detergent fibre (NDF) at pre – lamb, and soluble carbohydrate at docking.

When the effect of rate of N application was compared within each farm, there was still no significant effect of rate of application on pasture components.

Effect of type of N on pasture components

There was a significant difference in ME levels between the two N treatments; Sustain™ treated pasture had a mean ME level of 11.4MJ; whilst urea treated pasture had a mean ME level of 12.1MJ. This difference was significant at the 5% level.

Ewe and lamb loss rates

Usable data for ewe loss rate between paddocking out and weaning was available for 39 paddocks. In 6 paddocks loss rates appeared to be negative, where ewes had been added to paddocks. These paddocks were not included in any analysis of loss rates. A further 9 paddocks had no data collected.

7 paddocks had ewe loss rates of zero; the mean was 3%, and the highest ewe loss rate was 15%.

Usable data for lamb loss rate from birth to weaning was available for only 16 paddocks. In four paddocks the loss rates appeared to be negative and these were excluded. The average lamb loss rate was 19%, with 7 paddocks having loss rates of 5% to 10%; the highest recorded loss rate was 41%.

The paddocks with high lamb loss rates did not necessarily have high ewe loss rates, and the paddocks with high ewe loss rates tended to have lamb loss rates around the average.

Relationships between pasture constituents and survival outcomes

There were no significant relationships between pasture constituents and ewe or lamb survival/loss rates.

Relationship between N rate/type and survival outcomes

There were no significant relationships between the rate of N application and ewe or lamb loss rates. There were similarly no relationships between type of N applied and ewe or lamb loss rates.

Effect of pasture constituents on ewe blood metabolic parameters

For the 22 groups of tagged ewes, the value of each metabolic parameter for each ewe (serum calcium, magnesium, BOH, BUN, and bile acids) was compared to the pasture constituent values in the paddock they were grazing. Linear regression analysis was used to determine any effect of pasture constituents on ewe blood metabolites. The mean number of ewes sampled per paddock was 17; on most farms 20 ewes were sampled, with an even split of thin ewes (< BCS 2) and better conditioned ewes (BCS 2.5 and above) in each sample group.

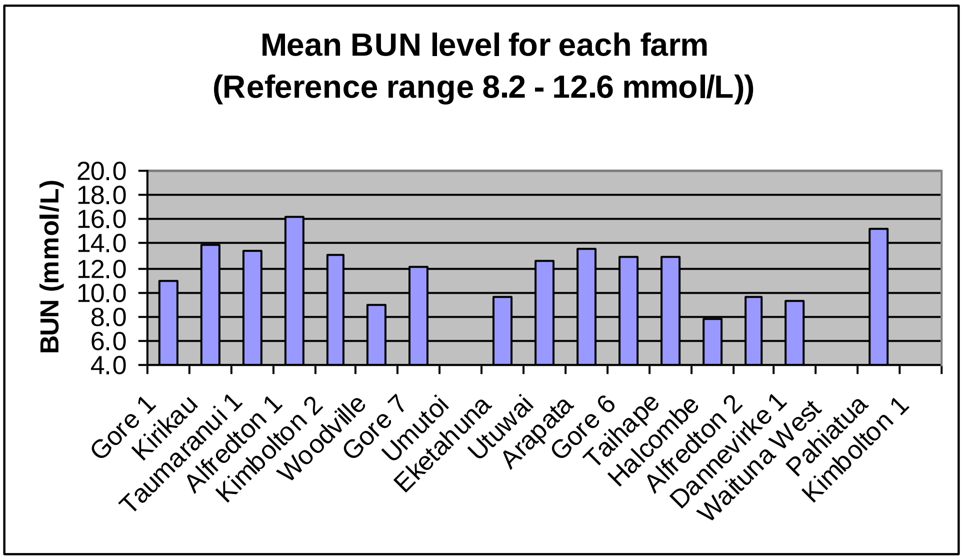
Table 2. Blood metabolite values for 373 ewes

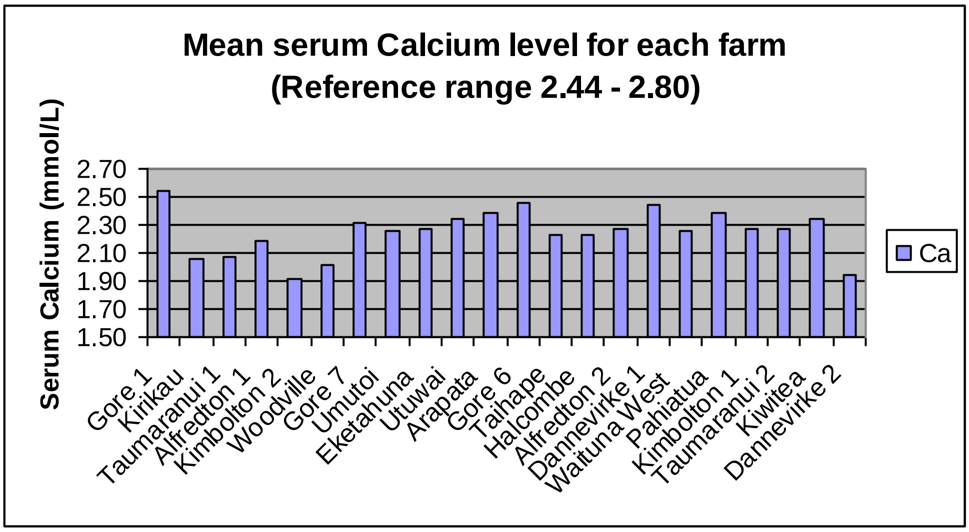
Metabolite	GGT	B Acids	BUN	Ca	Mg	BOH
Ref. range*	15 - 140	< 60	8.2 - 12.6	2.44 - 2.8	0.78 - 1.27	0.1 - 1.5
Mean	45	19.4	11.78	2.24	0.91	0.68
Highest value	219	135	44	2.85	1.32	2.9
Lowest value	15	1.9	1.04	1.05	0.1	0.2
Comment	219 an outlier - next value was 74	One farm had all ewes < 2. 8 ewes had values >60	28% (106) ewes had values above ref. range	77% (290) ewes had values below ref. range	20% (74) ewes Had values below ref. range	56% (212) ewes > 0.6 16% (60) ewes >1

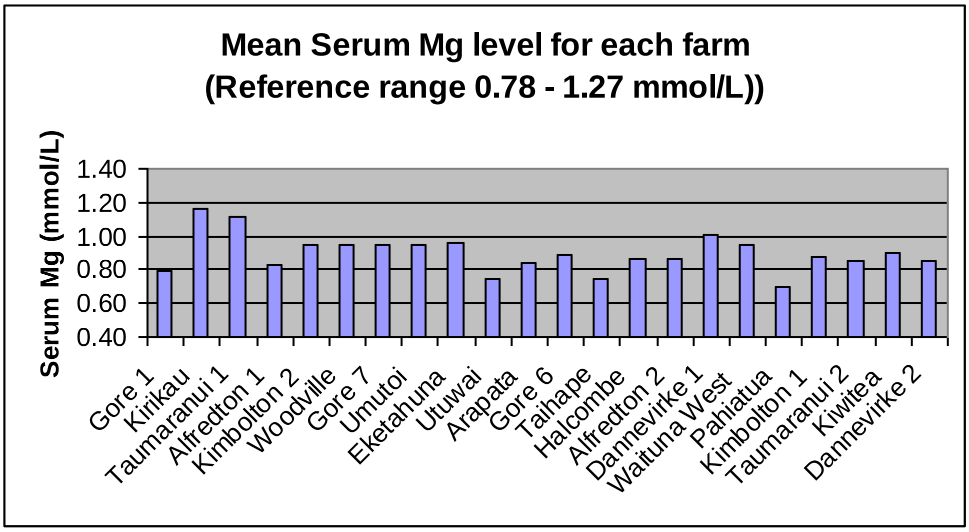
* Reference range supplied by Gribbles Alpha Hamilton, bile acid ref. range supplied by Dr. Fraser Hill, Gribbles Palmerston North

Almost 80% of the ewes in this study fell below the reference range for serum calcium. It is likely that the serum calcium levels found in this study are quite normal for twin bearing ewes within 10 – 14 days of parturition.

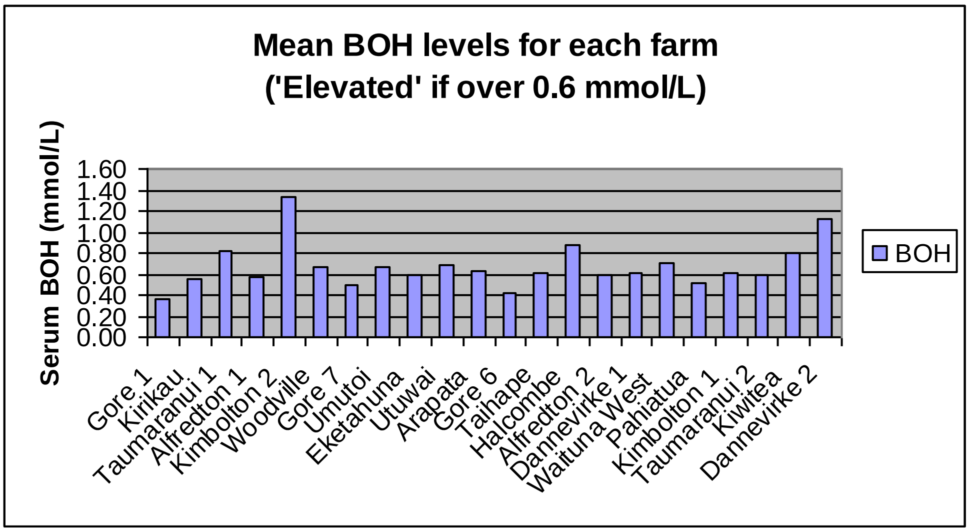
When the ewes were analysed as one group, there was no significant effect of pasture components on ewe metabolic parameters, but there were significant differences between farms for all blood values. Highly significant (0.01%) differences existed between farms for BUN, Ca and Mg.

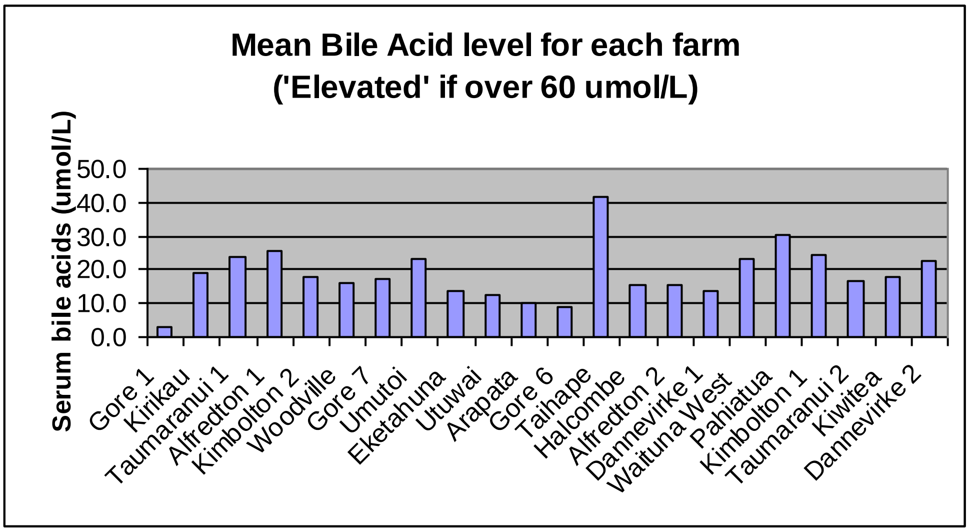






The differences between farms were significant at the 1% level for BOH and Bile Acids.





Blood metabolites in 'thin' versus 'fat' ewes

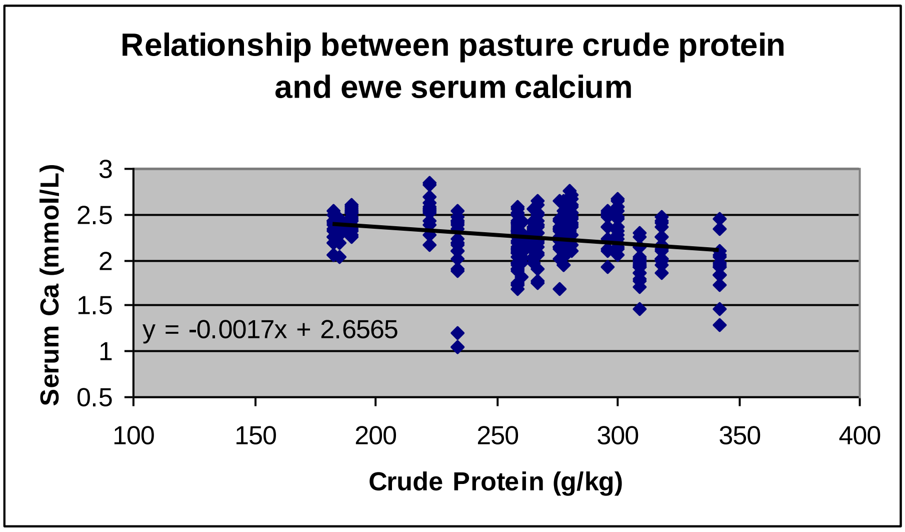
When the data was split to analyse the effect of pasture constituents on 'thin' (BCS<2.0) and 'fat' (BCS>/=2.5) ewes separately, there were no significant relationships between pasture constituents and blood metabolite values for the 'fat' ewes, but the following relationships existed for the 'thin' ewes:

Table 3: Relationship between pasture components and blood metabolite values for 'thin' ewes

Pasture Component	Metabolite	Relationship	Significance factor
ME	BUN	-ve	0.001
ME	Ca	-ve	0.001
NDF	BUN	-ve	0.01
NDF	Ca	+ve	0.001
NDF	Mg	+ve	0.001
NDF	BOH	-ve	.05
CP	Bacid	+ve	0.01
CP	BUN	+ve	0.001
CP	Ca	-ve	0.001
CP	BOH	+ve	0.01
SolCHO	Bacids	-ve	0.01
SolCHO	Ca	+ve	0.001
SolCHO	BOH	-ve	0.001

There was a significant 'lack of fit' between the farms in this analysis (despite the overall regression being significant, individual farms' mean blood values could differ significantly from that predicted by the regression).

When 'lack of fit' was used as the error term only the relationship between serum Ca and crude protein remained significant; at the 0.05 level.



However the relationships between Bile acids and BUN with crude protein, Bile acids with soluble carbohydrate, and serum magnesium with NDF came close to significance.

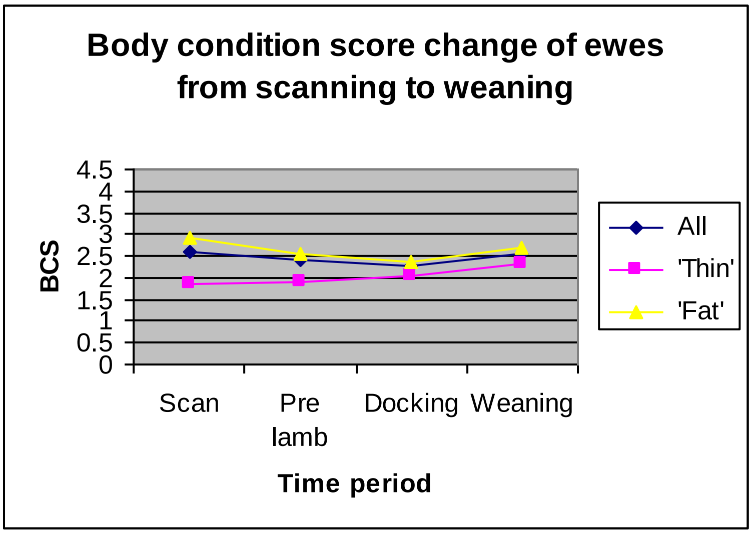
In terms of absolute differences between ‘thin’ and ‘fat’ ewes for the various blood metabolites, only serum Ca showed a significant difference. The mean serum Ca level for ‘fat’ ewes was 2.3 mmol/L, and for thin ewes; 2.17 mmol/L. This was significant at the 0.001 level.

Effects of ewe blood values on outcomes

There was no significant relationship between any of the ewe blood values and survival outcomes for ewes (using individual records) or lambs (using mean records for the paddocks).

Effects of ewe condition on survival outcomes

The following graph shows the pattern of body condition score change over the study period:



Between scanning and docking ‘thin’ ewes gained 0.16 of a BCS, whilst ‘fat’ ewes lost 0.53 of a body condition score.

Farms differed significantly in the difference between BCS1 and BCS3 but not in the behaviour of ‘thin’ versus ‘fat’ ewes.

‘Thin’ ewes did not have a significantly different risk of being dead or absent at weaning compared to ‘fat’ ewes.

There was no significant relationship between ewe BCS at docking and lamb growth rate from docking to weaning, although there were only 16 datasets available for this analysis.

Discussion

Pasture analyses

This study has generated quite a large dataset of pasture quality and macro element analyses for hill country pasture from a range of sites for the late winter and spring period.

In general ME levels were high (for perennial pasture), remaining at greater than 11.5 MJ average throughout the period.

Crude protein levels were moderate, with only 10 samples returning levels of over 300g/kg in the period after N application; interestingly, 6 of these 10 samples came from 2 farms – but this could not be shown to be related to the concurrent N application.

Soluble carbohydrate levels varied significantly between farms; this variation may have been exacerbated by the way the samples were handled; as soluble carbohydrate levels drop quickly if samples are not immediately cooled after collection.[6] In general, levels were low to moderate.

Dietary cation – anion difference is an area that has not received much attention with regards to sheep pastures. In pasture fed dairy cattle, levels of less than 200 milliequivalents are accepted as being 'safe', with increasing risk of metabolic disease as levels rise above this. 'High risk' New Zealand dairy pastures regularly record levels over 600 meq.[7]

Interestingly, only four of the 60 pasture samples in the pre lamb period were below 200 meq; but 13 were over 500. Mean level varied from 326 – 391 meq. However there was no association seen between DCAD and ewe loss rates, despite the number of paddocks that, based on a dairy standard, would be thought to be somewhat risky.

Ewe and lamb loss rates

The limitations of a field study where farmers collect survival data was most evident in this part of the project. Of the 54 paddocks originally enrolled in the study, usable data on ewe loss rates was only available from 39 paddocks.

Ewe loss rates were generally lower than those from large paddocks in a commercial situation; 7 paddocks had ewe loss rates of zero; the mean was 3%, and the highest ewe loss rate was 15%. Further work is required to accurately profile the contributing factors to these higher ewe loss rates.

Usable data for lamb loss rate from birth to weaning was available for only 16 paddocks. The average lamb loss rate was 19%, which is in agreement with the national average[8]. The paddocks with high lamb loss rates did not necessarily have high ewe loss rates, and the paddocks with high ewe loss rates tended to have lamb loss rates around the average. However in a season with more severe weather the lamb loss rates in these paddocks are likely to have been much worse.

Nitrogen application, pasture components and ewe performance

The fact that we were unable to demonstrate any relationships between pasture components and ewe performance is not proof that such relationships do not exist.

This study was limited by the small number of sample periods (one pre lamb and one at docking), given that pasture components can alter rapidly depending on the weather, grazing level and reproductive state of the plant.

Another possible source of error is the method of pasture collection; whilst farmers were instructed to cut pasture at grazing height, the actual height of cutting and selection of site for sampling would have varied between farms and may have accounted in part for the significant differences between all farms for most of the pasture components. Other reasons for these differences are likely to be pasture species balance and previous grazing management.

A further complicating factor is that the pasture actually tested is only a rough guide to what animals actually choose to ingest; in general they will choose a diet of higher quality than the average of what is on offer. The degree to which they are able to do this is strongly correlated to pasture height, and this was not measured.

Finally, as the study design relied on the participating farmers to collect the survival and performance data, usable results were not available from every paddock and this has likely limited the power of the analyses.

In this study, no relationships were shown between N application and changes in pasture components, or between N application and ewe or lamb loss rates. The pasture component finding is again limited by the timing and frequency of sampling, but is consistent with other work that shows no or very minor changes.[4]

The effect of N type on pasture ME is interesting and may warrant further work. In practical terms this difference was unlikely to have caused a nutritional limitation to ewes on the Sustain™ treated paddocks.

Ewe blood metabolites

While there were no significant relationships between mean ewe blood parameters and performance, it was interesting that there were such significant differences between farms, and that on average this could not be explained by dietary components. However as mentioned above we did not measure pasture allowance per se and this could well have had a significant impact. Time off feed should not have played a role in these differences as this was standardised.

The findings for the thin ewes are extremely interesting - several pasture components had a significant relationship with the metabolic status of these ewes. The majority these relationships make biological sense:

- BUN levels were lower on pastures with high ME (energy) and NDF (effective fibre), and higher on pastures with high CP.
- Serum Ca levels were lower on high ME and high CP pasture, and higher on high NDF and soluble CHO pasture.
- Bile acids were raised with high CP and lowered with high soluble CHO pasture.
- BOH levels were raised with high CP pastures and lowered with high soluble CHO and NDF pastures.

From these relationships it would appear that raised pasture CP levels in particular have an association with less desirable blood metabolite parameters in thin ewes. The association of higher soluble CHO pastures with more desirable results is expected. The positive association with higher NDF values may suggest that dietary fibre is a limiting component in pasture for ewes at this time of the year; certainly this situation is true in many pasture based dairy systems.

Despite all this, no differences in survival were found for the ‘thin’ ewes compared to their better conditioned counterparts, and there was no relationship between their blood metabolite levels and death rates.

However, the September lambing period of 2006 was exceptionally kind climatically throughout most of the country. For example in the Manawatu; the average temperature for the month was 14.5°C, there were only 6 days where rain fell (50mm total), and the strongest wind gust was 46km/h (all measured at Palmerston North airport). Had the weather been more severe would the outcomes have been different for these thin ewes? It is also possible that the predominance of fine sunny weather at this time minimised any observed measured differences in pasture components.

Certainly these results suggest that thin ewes are likely to be more at risk metabolically in the immediate pre – lambing period, and emphasise the need for farmers to work to minimise the proportion of the flock below BCS 2.5 going into winter.

In this study, the thin ewes tended to gain weight from winter through to docking, but this is unlikely to be a reflection of the situation on an average farm, as in this study the individually identified ewes were in the main run as a separate small mob for ease of access for the farmer. However this does illustrate the positive effect of being able to separate these animals from the ‘mob pressure’ of normal winter management systems.

The results of this study suggest that the negative effects of N application to hill country pastures for lambing ewes are likely to be minor, both in terms of alteration of pasture components, and deleterious effects on ewe and lamb survival. Whether these outcomes might have been altered in a wet, cold and windy spring is an area that needs further research.

Although the thin ewes in this study did not have altered survival outcomes, their blood metabolic profiles were more likely to be altered in association with differences in pasture components, which may suggest they could be more at risk of metabolic disturbances under certain conditions.

Further work is required to accurately define the profile and causes of ewe loss over the lambing period on NZ hill country.

Acknowledgements

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