High weaned lamb live weight gains on herbs

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Abstract

Post-weaning lamb growth rates have not been determined in mixed swards containing herbs and legumes. An experiment was conducted to compare post-weaning lamb growth rates on *ad libitum* allowances of herb/legume- and ryegrass-based pastures. Three-hundred Romney ewe lambs were allocated to four permanent mixed-sward treatments under unrestricted grazing; herb/clover (chicory (*Cichorium intybus*) 'Choice', plantain (*Plantago lanceolata*) 'Ceres Tonic', red clover (*Trifolium pratense*) 'Sensation', white clover (*T. repens*) 'Tribute'); plantain/pasture (tetraploid perennial ryegrass (*Lolium perenne*) 'Stirling' (AR_1), white clover 'Tribute', plantain 'Ceres Tonic'); new pasture (tetraploid perennial ryegrass 'Stirling' (AR_1), white clover 'Tribute') and old pasture (diploid perennial ryegrass with wild-type endophyte, other grass species and white clover). There were three replicates of 25 lambs treatment^{-1}. The experiment was conducted over 50 days, after a 14-day herbage adjustment period. Unfasted live weights of all lambs were recorded weekly. Herbage height, masse and quality parameters were measured pre- and post-grazing. Lambs grew fastest ($P < 0.001$) on the herb/clover treatment (247 ± 7 g day^{-1} live weight) compared to new pasture (119 ± 7 g day^{-1}), old pasture (119 ± 7 g day^{-1}) and plantain/pasture (107 ± 7 g day^{-1}), which were not significantly different. The results showed that under unrestricted feeding, lambs could grow at high rates on an herb/clover permanent sward mix.

Additional key words: *Cichorium intybus*, *Plantago lanceolata*, *Trifolium repens*, *Trifolium pratense*, pasture, legumes.

Introduction

Many New Zealand farmers use relatively short-term crops such as hybrid leafy turnip to finish lambs for slaughter or to grow replacement stock to facilitate management practices such as hogget mating. However, these annual crops often require two cultivations close together. Regular cultivation can be expensive and is not always environmentally sound (Kemp *et al.*, 2002). Therefore, there are advantages in using a high nutritive value, permanent (lasting at least five years) pasture to finish lambs. Additionally, it will provide the flexibility to lift sheep performance during other periods of the year. A pasture mixture based on herbs and legumes was reported to have superior herbage quality, and similar or greater annual dry matter (DM) production than perennial ryegrass/white clover pasture, whilst having greater tolerance to dry summers (Goh and Bruce, 2005). Grazing legumes and/or herbs has increased sheep resilience to internal parasitism (Athanasiadou *et al.*, 2006).

Individual legume and herb species have regularly been shown to support sheep growth rates and give health levels that are substantially better than is possible on permanent ryegrass/white clover swards. Post-weaning lamb growth rates on individual legumes and

herb species are greater than on perennial ryegrass/white clover pasture (Jagusch *et al*., 1981; Hare *et al*., 1987; Fraser *et al*., 1988; Holst *et al*., 1998; Moorhead *et al*., 2002; Marley *et al*., 2005;).

The faster a lamb grows prior to and following weaning, the sooner it can be slaughtered at a desired weight, and the more efficient it is at converting herbage to meat. This is due to a lower proportion of the total feed requirement contributing to maintenance, and more to growth (Rattray *et al.*, 1976). The average daily live weight gain (LWG) for weaned lambs in New Zealand is approximately 150 g day^{-1} (Kerr, 2000) compared to 200 g day^{-1}, or more, on white and red clover, chicory and plantain (Jagusch *et al*., 1981; Holst *et al*., 1998; Moorehead *et al*., 2002).

To date, post-weaning growth rates have not been determined on lambs grazing mixed swards containing herbs and legumes. Therefore, as part of a long-term evaluation of the persistence and management of herb-based pastures, a study was conducted in the summer and early autumn of 2007 to compare post-weaning growth rates of lambs on *ad libitum* allowances of herb/legume- and ryegrass-based pastures.

Materials and Methods

Three-hundred weaned, Romney ewe lambs (five months old) with an average live weight of 33.1 ± 0.1 kg were allocated to four permanent sward mix treatments; herb/clover (chicory (*Cichorium intybus*) 'Choice', plantain (*Plantago lanceolata*) 'Ceres Tonic, red clover (*Trifolium pratense*) 'Sensation', white clover (*Trifolium repens*) 'Tribute') (n = 75); plantain/pasture (tetraploid perennial ryegrass (*Lolium perenne*) 'Stirling' (AR_1), white clover 'Tribute', plantain 'Ceres Tonic') (n = 75); new pasture (tetraploid perennial ryegrass 'Stirling' (AR_1), white clover 'Tribute') (n = 75); and old pasture (diploid perennial ryegrass with wild-type endophyte, other grass species and white clover at least five years of age) (n = 75). There were three replicates on each herbage treatment (n = 25) at 4.8 ha $treatment^{-1}$. The experiment was conducted at Keeble Farm, Massey University, 5 km South of Palmerston North on a Tokomaru silt loam soil with a long history of annual superphosphate applications.

Lambs were introduced to respective herbage treatments on 5 February 2007 (D_{-14}). The first 14 days of the experiment was classed as an adjustment period (D_{-14} to D_0). During this period, lambs were managed as in the later experimental period to allow them to adjust to the different herbage types. The adjustment period was followed by a 50-day main experimental period that finished on 12 April 2007 (D_1 to D_{50}).

The unfasted live weight of all lambs was recorded on D_1, D_8, D_{15}, D_{22}, D_{29}, D_{36}, D_{43} and D_{50}. Herbage mass and height were measured pre- and post-grazing, using quadrat cuts (Frame, 1993) and a sward stick, (Bircham, 1981), respectively. In each pre- and post-grazing paddock herbage DM was estimated from three 0.1 m^2 quadrat cuts $replicate^{-1}$ in the 'new' and 'old pasture' treatments, and three 0.25 m^2 quadrat cuts $replicate^{-1}$ in each 'plantain/pasture' and 'herb/clover' treatment.

All herbage cuts were to ground level and the herbage was washed before drying; in a forced draught oven for at least 24 hrs at 70 °C (Staff, 1961). Starting on D_8, fifty sward stick measurements were taken in each paddock pre- and post-grazing in all herbage treatments (Bircham, 1981) to determine surface height of the pasture.

Pre-grazing, three herbage species composition samples of approximately 200 g wet weight were taken from each replicate $treatment^{-1}$, excluding the old pasture treatment.

Three herbage enclosures were placed randomly on each paddock prior to grazing and left for the duration of that grazing period. Post-grazing, a 'hand-plucked' sample of approximately 100 g wet weight was taken from in each cage (Frame, 1993). Samples were freeze dried and ground prior to analysis. Freeze-dried samples were analysed for

digestibility (and hence metabolisable energy) (Roughan and Holland, 1977), crude protein (CP) (total combustion method), and neutral detergent fibre (NDF) (Robertson and van Soest, 1981).

Data were analysed using the PROC Glm procedure in SAS version 9.1 (SAS, 2006). Fixed effects were the four permanent sward mix treatments ('herb/clover'; 'old pasture; new pasture; and plantain/pasture) nested within replicates. Live weight gains week^{-1} were analysed using repeated measures analysis of variance (Gill and Hafs, 1971). The PROC genmod was used to analyse the frequency of live weight gains of less than 100 g day^{-1} and more than 200 g day^{-1}.

Results

Mean pre-grazing heights were 13.8 ± 0.4, 15.1 ± 0.4, 13.6 ± 0.4 and 10.6 ± 0.4 cm and mean post-grazing heights were 8.8 ± 0.2, 11.1 ± 0.2, 11.1 ± 0.2 and 9.9 ± 0.2 cm for herb/clover, plantain/pasture, new pasture and old pasture, respectively. The pre- (3681 ± 407 kg DM ha^{-1}) and post-grazing (3050 ± 359 kg DM ha^{-1}) herbage masses were similar for herb/clover, plantain/pasture, and new pasture, but were 5552 ± 407 and 4578 ± 359 kg DM ha^{-1}, respectively, for old pasture.

The botanical composition at D_1 for herb/clover was 40 % chicory, 30 % plantain, 5 % red clover and 2 % white clover. The plantain/pasture treatment contained 45 % plantain, 37 % ryegrass and 2 % white clover, and the new pasture was 85 % perennial ryegrass and 2 % white clover. White clover had increased to 5 % by D_{50}.

During the period D_1 to D_{50}, the herb/clover-treatment had higher ($P < 0.001$) digestibility and metabolisable energy (ME), while new pasture had the highest CP concentration ($P < 0.001$). Old pasture had the highest ($P < 0.001$) NDF concentration of all treatments groups, respectively (Table 1). Lambs on the old-pasture-treatment showed little or no LWG due to ryegrass staggers during the period D_{22} to D_{43}.

Table 1: The effect of permanent-mixed-sward treatment (herb/clover vs. plantain/pasture vs. new pasture vs. old pasture) on mean pooled herbage quality (digestibility (OMD), crude protein, neutral detergent fibre (NDF), and metabolisable energy (ME)), during the D_1 to D_{50} study period.

Treatment	OMD (% of DM)	Protein (% of DM)	NDF (% of DM)	ME (ME, MJME kgDM^{-1})
Herb/clover	82.9^{d}	15.8^{ab}	28.1^{a}	11.4^{d}
Plantain/pasture	72.9^{c}	12.9^{a}	39.9^{b}	10.2^{c}
New pasture	64.1^{b}	19.6^{b}	48.1^{c}	9.0^{b}
Old pasture	61.2^{a}	14.1^{a}	53.7^{d}	8.8^{a}
s.e.[1]	0.9	2.2	1.8	0.1

[1] = pooled standard error.

Means within columns with different superscripts are significantly different (P<0.001).

At D_{50}, the herb/clover-treatment lambs were heavier ($P < 0.001$) than the new-pasture- and plantain/pasture-treatment lambs, which were heavier ($P < 0.001$) than the old-pasture-treatment lambs (Table 2). FromD_1 to D_{50}, the herb/clover-treatment lambs had faster average daily live weight gains ($P < 0.001$) than all the other treatment groups, which did not differ significantly.

Table 2: The effect of permanent-mixed-sward treatment (herb/clover vs. plantain/pasture vs. new pasture vs. old pasture) on lamb live weight at days 1 (D_1), 15 (D_{15}), 36 (D_{36}) and 50 (D_{50}) and average daily live weight gain (ADG) during the D_1 to D_{50} study period.

	Live weight (kg)				
Treatment	D_1	D_{15}	D_{36}	D_{50}	ADG (g d^{-1}
Herb/clover	35.3^b	39.4^c	42.8^c	47.4^c	247^b
Plantain/pasture	36.7^c	40.4^c	40.4^b	41.5^b	107^a
New pasture	35.6^b	38.5^b	39.9^b	41.5^b	119^a
Old pasture	33.8^a	37.3^a	37.4^a	39.6^a	119^a
s.e.[1]	0.2	0.4	0.3	0.4	7

[1] = pooled standard error.

Means within columns with different superscripts are significantly different (P<0.001).

Significantly (P < 0.001) more herb/clover-treatment lambs grew faster than 200 g day^{-1} during D_1 to D_{50} (logit 1.87 ± 0.34; 86.6%), compared to both pasture/plantain- (logit –3.16 ± 0.59; 4.1%) and new-pasture-treatment lambs (logit –3.60 ± 0.72; 2.7%). No old-pasture-treatment lambs grew faster than 200 g day^{-1} (Figure 1).

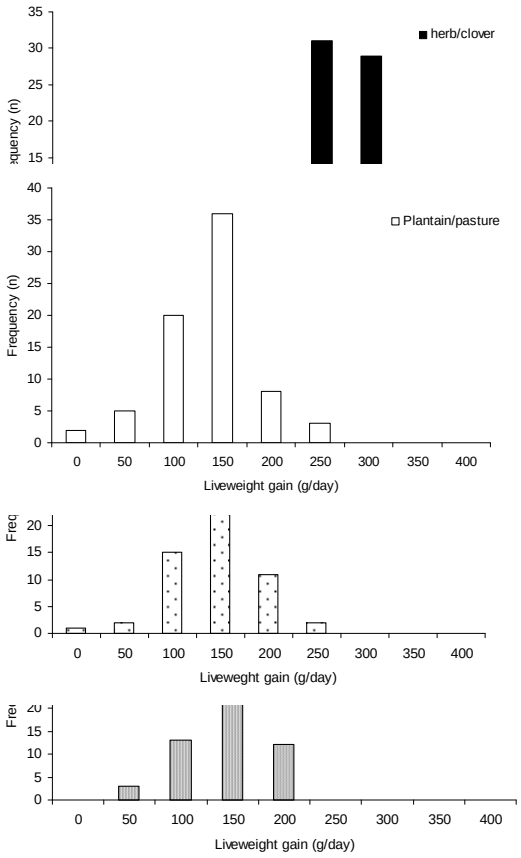

Figure 10: The effect of permanent mixed-sward treatment (herb/clover vs. plantain/pasture vs. new pasture vs. old pasture) on the frequency of live weight gain during the D_1 to D_{50} study period. Values denote live weight gains up to and including that value, e.g. 200 denotes 151 - 200 g day^{-1}.

Discussion

Lambs grew fastest on the herb/clover-treatment compared with the other three treatments. Lamb performance on the herb/clover mix has not been previously examined. However, in both New Zealand and Australia lamb live weight gains have been reported to be higher on pure chicory compared with pure perennial ryegrass swards (Hare *et al*., 1987; Fraser *et al*., 1988; Holst *et al*., 1998). Similarly, live weight gain has been reported higher for lambs grazing pure plantain than pure perennial ryegrass swards (Moorhead *et al.*, 2002). Jagusch *et al.* (1981) reported faster lamb growth on red clover compared with a perennial ryegrass/white clover pasture. Further, Marley *et al.* (2005) reported faster lamb growth on pure red and white clover, respectively, compared to pure perennial ryegrass. Therefore, it is not unexpected that the lambs grew faster on the herb/clover pasture than on perennial ryegrass based pastures.

The higher ME concentration of the herb/clover forage, in conjunction with a lower NDF content, most likely was the reason for the higher lamb growth rates than in the other treatment groups. The low percentage of white clover, in all treatments, was due to a severe clover root weevil infestation which would have decreased the feeding value of the pasture and plantain/pasture treatments. Hodgson and Brookes (1999) stated that increases in the NDF concentration can lower animal performance due to decreases in CP and ME concentrations, whilst restricting animal intake due to low rumen outflow. Previously, chicory was found to have a higher ME than white clover and perennial ryegrass (Burke *et al.*, 2002). Komolong *et al.* (1992) and Collins and McCoy (1997) reported NDF concentrations in chicory were lower than those observed in perennial ryegrass. Hodgson and Brookes (1999) recommended that the CP concentration for any herbage should be between 15 and 18 % for good lamb growth. The old pasture and the plantain/pasture treatments had CP concentrations lower than this recommendation, but CP concentration was unlikely to be the main cause of differences in lamb performance among treatments.

Lamb LWGs on the plantain/pasture treatment were lower than expected from earlier research on separate pastures of plantain and of ryegrass and white clover (Jagusch *et al*., 1981; Moorhead *et al*. 2002). It was observed that lambs on this treatment preferred ryegrass and white clover to plantain. This resulted in ungrazed, mature plantain leaves becoming prominent in the pasture. Grazing management that ensures plantain is grazed more frequently than in this experiment needs to be evaluated before the usefulness of a plantain/pasture mix can be fully determined.

From D_{22} to D_{43}, lambs on the old pasture treatment experienced a period of little or no growth. This was attributed to the effects of ryegrass staggers, due to the lambs consuming ryegrass infected with wild endophyte. Lambs on wild-type endophyte have depressed growth rates compared to lambs on endophyte-free perennial ryegrass (Fletcher, 1983; Ryan and Widdup, 1997).

Of lambs on the herb/clover treatment, 87 % grew faster than 200 g day^{-1}, and none grew at less than 150 g day^{-1} from D_1 to D_{50}. In comparison, only 4.1 and 2.7 % of plantain/pasture and new pasture lambs grew faster than 200 g day^{-1}, while no lambs achieved this growth rate on the old pasture treatment. This has practical implications for commercial farming where a higher proportion of lambs growing faster than 200 g day^{-1}, with all growing faster than 150 g day^{-1}, would allow farmers to slaughter more lambs earlier, gaining premium prices, freeing up more land for other stock classes and reducing labour requirements and animal health costs.

Conclusions

Over the late summer/early autumn period of this experiment, lambs on the herb/clover treatment had higher average daily live weight gains than lambs on the plantain/pasture,

new pasture and old pasture treatments, which did not differ. The difference was related to forage quality, in particular the NDF and ME concentrations, where the herb/clover treatment had the lowest NDF and highest ME, resulting in a high-energy feed that had high rumen outflow rates leading to higher intakes. The choice of herbage species used, during late summer/early autumn, to achieve high lamb live weight gains depends on an individual operation. However, there is now evidence to show that with unrestricted feeding, lambs can grow at high rates on a herb/clover permanent sward mix.

References

Athanasiadou, S., Kyriazakis, I. and Jackson, F. 2006. Can plant secondary metabolites have a role in controlling gastrointestinal nematode parasitism in small ruminants? Herbivores: Assessment of Intake, Digestibility and the Roles of Secondary Compounds, Nottingham University Press, Nottingham. pp. 197-207.

Bircham, J.S. 1981. Herbage growth and utilisation under continuous management, Unpublished PhD, University of Edinburgh, Edinburgh.

Burke, J.L., Waghorn, G.C. and Chaves, A.V. 2002. Improving animal performance using forage-based diets. *Proceedings New Zealand Society of Animal Production* 62, 267-272.

Collins, M. and McCoy, J.E. 1997. Chicory productivity, forage quality, and response to nitrogen fertilization. *Agronomy Journal* 89, 232-238.

Fletcher, L.R. 1983. Effects of presence of *Lolium* endophyte on growth rates of weaned lambs, growing on to hoggets, on various ryegrasses. *Proceedings New Zealand Grassland Association* 44, 237-239.

Frame, J. 1993. Herbage mass. In: A. Davies, R.D. Baker, S.A. Grant and A.S. Laidlaw (Eds), Sward Management Handbook, British Grassland Society.

Fraser, T.J., Cosgrove, G.P., Thomas, W.J., Stevens, D.R. and Hickey, M.J. 1988. Performance of Grasslands Puna chicory. *Proceedings New Zealand Grassland Association* 49, 193-196.

Gill, J.L. and Hafs, H.D. 1971. Analysis of repeated measurements of animals. *Journal of Animal Science* 33, 331-336.

Goh, K.M. and Bruce, G.E. 2005. Comparison of biomass production and biological nitrogen fixation of multi-species pastures (mixed herb leys) with perennial ryegrass-white clover pasture with and without irrigation in Canterbury, New Zealand. *Agriculture Ecosystems and Environment* 110, 230-240.

Hare, M.D., Rolston, M.P., Crush, J.R. and Fraser, T.J. 1987. Puna chicory - a perennial herb for New Zealand pastures. *Proceedings Agronomy Society of New Zealand* 17, 45-49.

Hodgson, J. and Brookes, I.M. 1999. Nutrition of grazing animals. In: J.G.H. White and J. Hodgson (Eds), New Zealand pasture and crop science, Oxford University Press, Auckland, pp. 117-132.

Holst, P.J., Kemp, D.R., Goodacre, M. and Hall, D.G. 1998. Summer lamb production from Puna chicory (*Cichorium intybus*) and lucerne (*Medicago sativa*). Animal Production in Australia. *Proceedings Australian Society of Animal Production* 22, 145-148.

Jagusch, K.T., Duganzich, D.M., Winn, G.W. and Rattray, P.V. 1981. The effect of season of the year and pasture allowance on the growth of lambs fed different pasture species. *Proceedings New Zealand Society of Animal Production* 41, 117-118.

Kemp, P.D., Matthew, C. and Lucas, R.J. 2002. Pasture species and cultivars. In: J.G.H. White and J. Hodgson (Eds), New Zealand Pasture and Crop Science, Oxford University Press, Auckland, pp. 83-99.

Kerr, P., 2000. 400 plus: a guide to improved lamb growth for farmers and advisors. New Zealand Sheep Council, Wellington.

Komolong, M., Nicol, A.M., Poppi, D.P., Fraser, T.J. and Kirsopp, S. 1992. Nutrient supply for lamb growth from Grasslands Puna chicory (*Cichorium intybus*) and Wana cocksfoot (*Dactylis glomerata*). *Proceedings New Zealand Society of Animal Production* 52, 85-97.

Marley, C.L., Fraser, M.D., Fychan, R., Theobald, V.J. and Jones, R. 2005. Effect of forage legumes and anthelmintic treatment on the performance, nutritional status and nematode parasites of grazing lambs. *Veterinary Parasitology* 131, 267-282.

Moorhead, A.J.E., Judson, H.G. and Stewart, A.V. 2002. Live weight gain of lambs grazing 'Ceres Tonic' plantain (*Plantago lanceolata*) or perennial ryegrass (*Lolium perenne*). *Proceedings New Zealand Society of Animal Production* 62, 171-173.

Rattray, P.V., Morrison, M.C.L. and Farquhar, P.A., 1976. Performance of early-weaned lambs on lucerne and pasture. *Proceedings New Zealand Society of Animal Production* 36, 179-183.

Robertson, J.B. and van Soest, P.J. 1981. The detergent system of analysis and its application to human food in the analysis of dietary fibre in food. In: W.P.T. James and O. Theander (Eds), Vol. 3, Marcel Dekker Inc., New York.

Roughan, P.G. and Holland, R. 1977. Predicting *in vivo* digestibilities of herbages by exhaustive enzymic-hydrolysis of cell-walls. *Journal of the Science of Food and Agriculture* 28, 1057-1064.

Ryan, D.L. and Widdup, K.H. 1997. Lamb and hogget growth on different white clover and ryegrass cultivar mixtures in southern New Zealand. *Proceedings New Zealand Society of Animal Production* 57, 182.

SAS. 2006. SAS 9.1, SAS Inst. Inc.

Staff, G.R.I. 1961. Research techniques in use at the Grassland Research Institute, Hurley. Commonwealth Agricultural Bureaux, Farnham Royal.