Liveweight gain of young sheep grazing perennial lupin-cocksfoot pasture compared with pure lucerne pasture

Liveweight gain of young sheep grazing perennial lupin-cocksfoot pasture compared with pure lucerne pasture

Alistair Black[1], **Travis Ryan-Salter**[1], **Gavin Loxton**[2] **and Derrick Moot**[1]

[1]Faculty of Agriculture and Life Sciences, PO Box 85084, Lincoln University, Lincoln 7647, New Zealand; [2]Sawdon Station, PO Box 9, Lake Tekapo 7945, New Zealand

Corresponding Author's e-mail: alistair.black@lincoln.ac.nz

Abstract
The liveweight gains of young sheep grazing on perennial lupin-cocksfoot pasture and pure lucerne pasture were compared under dryland (no irrigation) conditions at Lincoln University, Canterbury, New Zealand. This paper reports the results of the first year after establishment (July 2014 to April 2015). Total liveweight gain was 731 kg/ha for the lupin-cocksfoot pasture compared with 1146 kg/ha for the lucerne. The lupin-cocksfoot pasture yielded 6550 kg DM/ha whereas the lucerne yielded 9410 kg DM/ha. The average botanical composition of herbage offered to the sheep was 23% perennial lupin and 68% cocksfoot compared with 94% lucerne. Water use efficiency was higher for lucerne than lupin-cocksfoot when expressed in liveweight gain (3.1 and 2.1 kg/ha per mm of water used) and in herbage yield (24 and 18 kg DM/ha per mm). Overall the lupin-cocksfoot pasture was approximately 65-70% as productive as the lucerne pasture in the first year. These results support the use of perennial lupin-cocksfoot pasture as an alternative forage option in extensive grasslands where cultivation of lucerne is unsuitable.

Keywords: dryland, *Dactylis glomerata*, *Lupinus polyphyllus*, *Medicago sativa*, water use.

Introduction
As global industry competitors in meat and wool production, sheep farmers in the high country of the South Island of New Zealand (NZ) face the challenge of increasing efficiency and productivity. This challenge can be met, at least in part, by the cultivation of pasture species that are adapted to the difficult climatic and soil conditions. The expansion of the area planted in lucerne (*Medicago sativa*) is an obvious and widely adopted option (Anderson *et al.*, 2014). However, lucerne is unsuitable for many regions where low pH, high exchangeable aluminium, and low phosphorus in soils severely restricts its economic use. Other pasture legumes used in NZ are also unsuitable for these conditions. Therefore, alternative pasture options that combine different pasture species are required.

One possible opportunity for enhancing sheep production on high country farms may involve a system where cocksfoot (*Dactylis glomerata*) is grown with perennial lupin (*Lupinus polyphyllus* × *Lupinus* spp. hybrids). Cocksfoot is widely regarded in NZ as a persistent and productive grass that can persist under dry summer conditions and low soil fertility. A long term grazing trial and observations of wild populations in the South Island high country indicate perennial lupin survives the climate and has provided an ongoing source of forage over 30 years. It has been successful in trial plots and is adapted to low pH and low phosphorus soils (Scott, 2014). However, there has been little commercial sowing of perennial lupin in the high country.

This research was developed to enhance the potential of perennial lupin-cocksfoot pasture as a viable forage option for high country farms. The performance of Merino sheep grazing on perennial lupin-grass pasture was quantified on-farm at Sawdon Station, Tekapo (44°03'54"S, 170°29'22"E, elevation 677 m), using one of only a few commercial stands of perennial lupin in the district (Black *et al.*, 2014). To complement this investigation, a more intensive grazing study was established at Lincoln University, Canterbury (43°38'53"S, 172°27'24"E, elevation 9 m). The aim was to evaluate a perennial lupin-cocksfoot pasture relative to a conventional pure lucerne pasture in terms of their sheep liveweight gain, herbage yield and water use efficiency under dryland (no irrigation) conditions. This paper reports the results of the first year after establishment of the Lincoln grazing trial.

Materials and methods

An area of 2 ha was subdivided into three 0.52 ha blocks. Half of each block was randomly allocated a perennial lupin ('Blue' and 'Russell')-cocksfoot ('Kara') pasture or a lucerne ('Force4') pasture. The pastures were drilled into a cultivated seedbed on 5 December 2013. Each of the six 0.26 ha plots was fenced with permanent fences and supplied with stock water; they were divided into five equal "breaks" using temporary electric fences for rotational grazing within each plot. The soil was a Templeton silt loam with pH 6, Olsen P 17 mg/L and sulphate S 1 mg/kg.

In the spring of 2014, ewe hoggets (Coopworth breed, 11-12 months old) were brought on to the plots when the average herbage mass of the pasture was approximately 2000 kg of dry matter (DM)/ha. This occurred on 5 August for lupin-cocksfoot and on 15 September for lucerne. The average live weight of the hoggets at the start of grazing was 38.9 kg and 46.6 kg for lupin-cocksfoot and lucerne, respectively. The stocking rate, duration of grazing and interval between grazing for each break in the rotational grazing system were adjusted regularly between and within plots based on pasture growth rate and average herbage mass. All hoggets were shorn on 28 November 2014 and on 18 February 2015 they were replaced by new ewe lambs (Coopworth, 5-6 months old, average live weight 33.7 kg).

Sheep were weighed unfasted each day they were shifted to the next break in the grazing rotation (every 4-12 days). Liveweight gain was calculated as the change in mean live weight of two or three core animals per group since the previous weighing multiplied by the stocking rate.

Herbage mass was measured in each break every 2 weeks in winter (1 July to 5 August) and then each day the sheep were shifted, using a calibrated sward stick. Herbage yield was the change in herbage mass since the previous measurement. Breaks that were grazed during this interval were excluded from the yield calculation. Botanical composition was determined in each break before grazing by separating and drying quadrat samples. Herbage mass and composition were also quantified every 2-3 days for the duration of each grazing of one break per plot, to determine the acceptance of perennial lupin, cocksfoot and lucerne by the sheep.

Soil moisture was determined in one break per plot on 20 August and then each day the sheep were shifted, using a Time Domain Reflectometer (0-0.2 m depth) and a Neutron Probe (0.2-2.3 m). The amount of water used since the previous measurement, including during grazing, was calculated as rainfall minus the change in soil moisture content.

Results and discussion

The hoggets and lambs grazing on the lucerne grew faster ($P<0.05$) than those on the lupin-cocksfoot pasture (Figure 1A). Average daily gains for lucerne and lupin-cocksfoot were 303 and 211 g/day from the start of grazing to shearing on 28 November, 279 and 151 g/day from shearing to 18 February, and then 179 and 146 g/day until 24 April. The lupin-cocksfoot pasture had enough feed in early spring to start grazing 41 days earlier than the lucerne, but from then on the lucerne was able to support a higher stocking rate (average 19.1 and 15.0 sheep/ha, respectively). Therefore, the lupin-cocksfoot pasture produced more live weight in early spring, but its total liveweight gain was 731 kg/ha compared with 1146 kg/ha for lucerne (Figure 1B).

Spring pasture growth started at about the same time for lupin-cocksfoot and lucerne, in early September (Figure 1C). After that growth was similar for both pastures until mid-November when it started to decrease for lupin-cocksfoot and increase slightly for lucerne. Lucerne growth eventually decreased in mid-January and was about the same as lupin-cocksfoot growth over the following summer and autumn months. However the total herbage yield of the lucerne was 9410 kg DM/ha compared with 6550 kg DM/ha for lupin-cocksfoot ($P<0.05$).

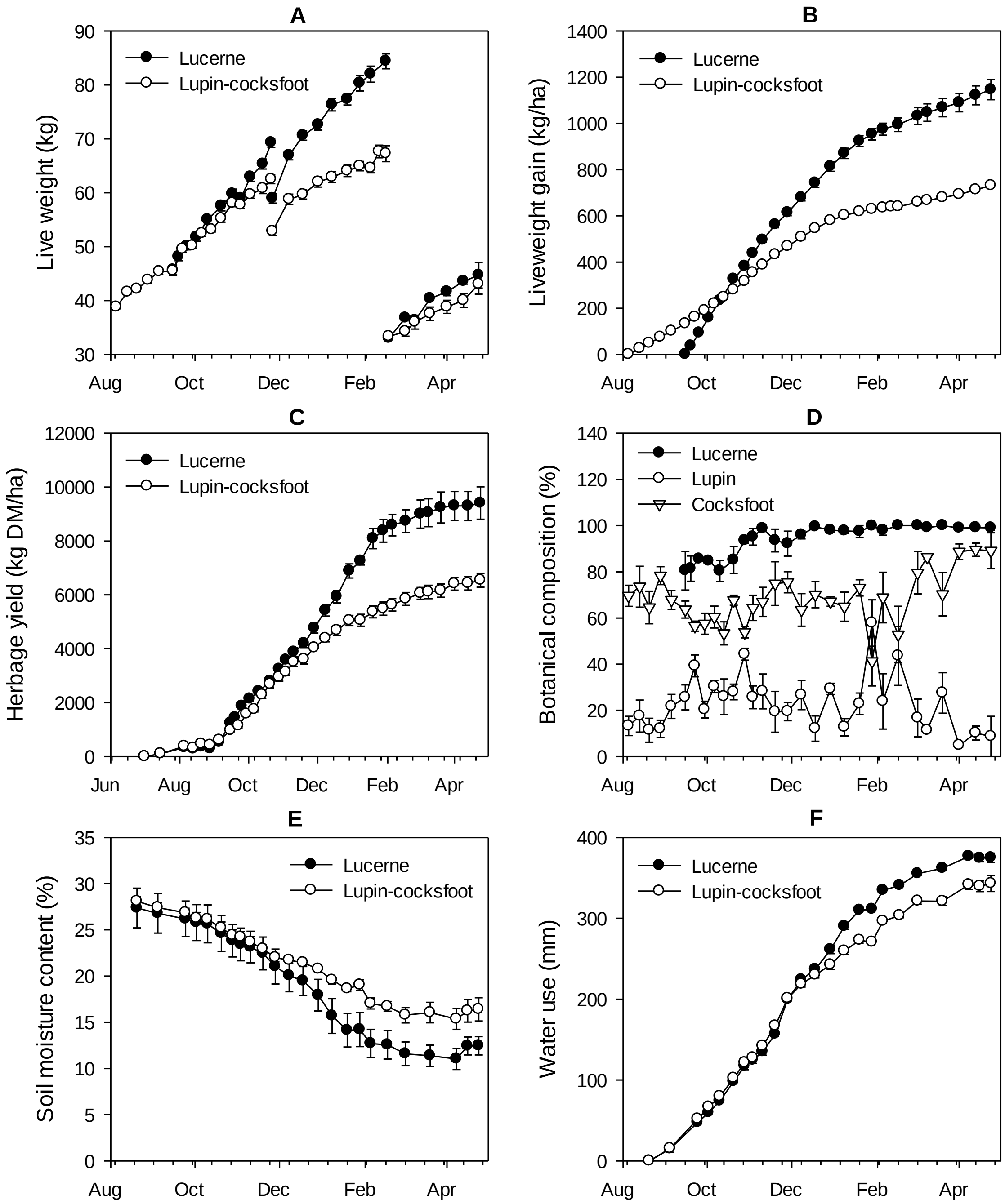

Figure 1. Seasonal changes in (A) live weight of young growing sheep, (B) liveweight gain, (C) herbage yield, (D) botanical composition of pre-grazing herbage, (E) soil moisture content to 2 m depth, and (F) water use of perennial lupin-cocksfoot and pure lucerne pastures in their first year after establishment (1 July 2014 to 24 April 2015) at Lincoln University, Canterbury, NZ. Error bars are SEM.

The average botanical composition of the herbage offered to the sheep was 23% perennial lupin and 68% cocksfoot compared with 94% lucerne (Figure 1D). The disappearance of herbage components during grazing indicated the sheep preferred to eat the leaves of cocksfoot before eating the leaves and petioles of perennial lupin, and preferred the leaves more than stems of lucerne. These results suggest the quality of the feed consumed was higher for the sheep grazing on the lucerne pasture than the lupin-cocksfoot pasture. Preliminary chemical analyses of the herbage support this conclusion.

The serial soil moisture readings indicated that the lupin-cocksfoot and lucerne pastures both extracted water to a maximum depth of 2 m. The soil moisture content to 2 m decreased to as low as 15.3% for lupin-cocksfoot and 11.0% for lucerne on 8 April (Figure 1E). When pasture growth started to noticeably decline (Figure 1C), soil moisture content was 22.9% for lupin-cocksfoot (19 November) compared with 14.1% for lucerne (19 January). From 20 August to 24 April, lupin-cocksfoot used 343 mm of water whereas lucerne used 375 mm (Figure 1F); rainfall was less than normal at 215 mm. Water use efficiency was higher ($P<0.05$) for lucerne than lupin-cocksfoot when expressed as liveweight gain per unit of apparent water use (3.1 and 2.1 kg/ha per mm) and as herbage yield (24 and 18 kg DM/ha per mm) over the same period.

Conclusions

The perennial lupin-cocksfoot pasture was about 65-70% as productive as the pure lucerne pasture in terms of liveweight gain of young sheep (64%), herbage DM yield (70%) and water use efficiency of liveweight gain (68%), under lowland conditions in a moderately fertile soil without irrigation in the first year after establishment.

Acknowledgements

We are grateful for the NZ Merino Company Ltd, Struthers Trust, Sinclair Cummings Trust and Alexander Agribusiness scholarships received by Ryan-Salter.

References

Anderson D., *et al.* (2014) *Proc NZ Grasslands Assoc*, 76, 29

Black A.D., *et al.* (2014) *Proc NZ Grasslands Assoc*, 76, 35

Scott, D. (2014) *Proc NZ Grasslands Assoc*, 76, 47