Lucerne for high quality summer feed in North Island hill country

A.W. MCGOWAN, G.W. SHEATH, AND R.W.WEBBY
AgResearch, Ruakura Research Centre, PB 3123, Hamilton, New Zealand
alec.mcgowan@agresearch.co.nz

Abstract

It is common to have a shortage of high quality summer feed on hill country farms in New Zealand, due to a deterioration of pasture growth during the drier months. Lucerne produces high quality feed during summer on lowland fields; however, its potential in hill country is unknown. This study measured the persistence of lucerne and evaluated its seasonal production relative to pasture. These results were then modelled for a typical sheep and beef farm to assess the potential benefits of including lucerne on the farm. Monthly growth rates of lucerne (six cultivars) and pasture were measured pregrazing, and lucerne viability was assessed at the end of the five-year study. Lucerne was successfully established and maintained on hill country for five years. On average, the total annual production of lucerne and pasture were similar, with only the highest yielding cultivar 'Rere' consistently outproducing pasture on an annual basis. Lower spring production of lucerne was compensated for by higher summer growth rates of 62 kg DM/ha/day, compared with 34 kg DM/ha/day for pasture. The extra summer feed from lucerne enabled a model farm that included 12.5% lucerne to carry more animals and produce lambs of heavier slaughter weight than on a pasture only basis. This gave a predicted increase in the gross margin of 3%. The impact of lucerne on other farms must be modelled individually to establish the best system to utilise the additional high quality summer feed.

Key words: lucerne, modelling, quality summer feed

Introduction

On hill farms in New Zealand, there is often a shortage of high quality stock feed during the summer months, due to a decline in both pasture quality and quantity. During periods of low rainfall and high temperatures, lucerne can produce high quality feed (ME equals 11.5; (Waghorn & Barry, 1987). Lucerne is usually grown on flat land where it is either grazed or mechanically harvested for conservation. Within the landscape mosaic of many hill farming systems, there is flat-rolling contour land where lucerne could be grown. On lowland country where lucerne is usually grown, it has a relatively short lifespan due to crown damage from grazing and weed invasion. At present the persistence of lucerne grazed on hill country is unknown and may be reduced by soil movement away from the crowns exposing them to greater hoof damage. Currently, there is a lack of literature on the use of lucerne as a summer feed for stock on hill country.

This study was established to determine whether lucerne has a role in providing high quality stock feed during the summer on hill farms. The aims of the study were to:

1. Evaluate the seasonal and annual production patterns of six cultivars of lucerne compared with pasture.
2. Measure the persistence of lucerne on a hill country site.
3. Use the field results to model a typical sheep and beef farm that includes lucerne to examine the impact on a farm system.

Materials and methods

Location and study site

A study was conducted at Whatawhata Research Centre (26 km west of Hamilton) on two adjacent north-facing sites on an approximately 20º slope. Both sites were originally established pasture swards, approximately 20 years old, with a botanical composition dominated by ryegrass (23%), browntop (9%) and white clover (10%). One site was used for the pasture measurements and the second site was used for lucerne establishment and measurements. For both sites the soil type was a Dunmore silt loam, (a yellow-brown loam, Anon.1954), which is a free draining volcanic ash. Prior to the study, a 'MAF Quick test' soil test (Cornforth & Sinclair 1984) was conducted at both sites. The results from the pasture site were: pH 5.4, Ca 5.6, K 14, P 15, Mg 30. The results from the lucerne site were: pH 5.6, Ca 6, K 12, P 19, Mg 15. On the basis of these results, the lucerne site received a basal dressing of 1 t/ha lime and 25 kg P/ha, (as 30% potassic super), and subsequent annual

dressings of 25 kg P/ha, (as 30% potassic super). The pasture received 25 kg P/ha/year as superphosphate.

Over the five years of the study, mean annual rainfall was 1 413 mm, and the mean monthly maximum and minimum air temperatures were 19.7 ºC and 7.5 ºC respectively (Table 1).

Table1 Summary of the monthly rainfall (mm) and monthly means of the daily mean air temperature (°C) from Whatawhata, New Zealand.

Monthly rainfall (mm)						
Month/Year	1982	1983	1984	1985	1986	1987
Jan	74	121	129	97	226	133
Feb	96	18	118	116	126	37
Mar	124	101	166	98	58	169
Apr	135	152	59	68	50	127
May	112	108	115	130	218	115
Jun	93	138	107	219	112	149
Jul	106	40	159	129	272	74
Aug	66	91	229	120	160	94
Sep	79	156	104	84	127	167
Oct	161	210	38	70	143	100
Nov	34	63	117	137	91	105
Dec	117	138	167	141	50	127
Total	1197	1336	1508	1409	1633	1397

Monthly mean of the daily mean air temp (°C)						
Month/Year	1982	1983	1984	1985	1986	1987
Jan	18.0	16.4	16.2	18.5	19.7	19.0
Feb	19.6	17.0	17.7	17.7	18.4	17.5
Mar	16.3	17.6	17.5	16.9	16.4	16.1
Apr	13.1	14.7	13.7	14.0	15.0	15.0
May	11.5	12.0	11.2	11.0	11.8	11.7
Jun	8.1	10.1	10.2	10.8	9.6	9.5
Jul	8.2	7.5	9.5	10.4	8.1	9.3
Aug	9.7	10.0	10.9	9.2	9.3	10.5
Sep	10.7	11.9	10.9	12.1	11.3	11.9
Oct	11.4	13.9	12.3	12.6	13.6	13.9
Nov	15.3	14.6	16.1	14.8	14.6	15.3
Dec	15.4	15.6	17.9	17.8	16.7	16.4

Pasture and management

The pasture was rotationally grazed except during early spring (i.e. September-October), when the area was continuously grazed. After each grazing, the pasture dry matter levels were visually assessed along five fixed transect lines. On each transect, a site representing the mean value was selected and trimmed to about 20 mm height, and a 0.2 m^2 exclusion cage was placed on the site. On the next measurement date (i.e. after grazing), the regrowth pasture was harvested and the cage repositioned. During the continuously grazed period the cages were harvested when the pasture reached 100 to 150 mm height. Depending on the rate of pasture growth, the regrowth period varied from 4 to 6 weeks with a total of nine harvests per year.

Lucerne establishment and management

Six cultivars of lucerne, 'Rere', WL318, 'Saranac', P521, AS13R and WL514, were chosen for their reputedly different seasonal growth patterns and overall disease resistance (Dunbier & Easton 1982). At the lucerne site, there were three equal size blocks of six plots measuring 7.5 x 9.5 m arranged down the hillside. For each of the three blocks, the six lucerne cultivars were randomly allocated to a plot. In October 1981, the lucerne was broadcast sown onto the cultivated (rotary hoed) plots at a seeding rate of 11.2 kg/ha, of slurry inoculated seed.

During the establishment phase, weeds were controlled in the lucerne plots by two sprayings of MCPB (1.0 *l* a.i. /ha). In subsequent years, weeds were controlled each winter by spraying with paraquat (0.5 kg a.i./ha) and simazine (1.0 kg a.i./ha). In the late spring, immediately following production measurements and grazing, weeds were also controlled using hexazinone (1.0 *l* a.i./ha). During summer 1983, there was an infestation of blue-green aphids that required one spraying of primicarb (125 g a.i./ha).

Table 2 Seasonal and annual dry matter production (kg/ha) of six lucerne cultivars and pasture grown on a north facing slope (20°) at Whatawhata from 1982 to 1987.

	Rere	WL318	Saranac	P521	AS13R	WL514	Sig.	SED
				1982/83				
Spr. 82	4 791	4 209	3 853	4 256	2 866	3 750	NS	611.6
Sum. 83	5 134	4 428	4 828	4 823	4 401	5 285	NS	488.9
Aut. 83	999	696	913	599	614	882	NS	145.5
Win. 83	1 565	1 371	1 372	1 173	1 023	1 092	NS	155.6
Year	12 489	10 704	10 966	10 851	8 904	11 009	NS	1 144.9
				1983/84				
Spr. 83	4 320	3 640	4 224	3 716	3 088	3 178	*	339.4
Sum. 84	5 883	6 256	5 357	4 750	4 848	4 821	**	347.6
Aut. 84	1 916	2 056	1 911	1 777	1 119	1 182	***	108.4
Win. 84	1 304	997	874	685	671	956	*	170.7
Year	13 423	12 949	12 366	10 928	9 726	10 137	**	752.4
				1984/85				
Spr. 84	3 608	3 788	3 016	2 723	2 776	2 534	**	287.6
Sum. 85	5 695	5 756	4 753	4 817	4 340	3 889	***	260.9
Aut .85	2 493	1 998	1 456	1 481	1 609	1 399	***	102.1
Win. 85	1 247	1178	844	716	685	597	***	99.1
Year	13 043	12 720	10 069	9 737	9 410	8 419	***	493.5
				1985/86				
Spr. 85	3 222	3 355	2 810	2 444	2 610	1 760	***	156.3
Sum. 86	5 938	6 004	4 758	5 292	5 200	3 628	***	248.2
Aut. 86	2 705	2 037	1 322	1 603	1 887	1 577	**	257.2
Win. 86	1 714	1 490	985	1 116	1 253	1 213	*	169.5
Year	13 579	12 886	9 875	10 455	10 950	8 178	***	515.9
				1986/87				
Spr. 86	3 805	3 906	3 303	3 348	3 996	3 269	*	208.8
Sum. 87	4 619	4 348	4 002	4 200	5 118	5 001	*	315.3
Aut. 87	2 298	1 964	1 649	1 690	1 795	1 768	NS	248.3
				Summary				
5yr.spr. mean	3 949	3 780	3 441	3 297	3 067	2 898	***	140.9
5yr. sum. mean	5 454	5 358	4 740	4 776	4 782	4 525	**	178.2
5yr. aut. mean	2 082	1 750	1 450	1 430	1 405	1 382	***	93.8
4yr. win. mean	1 457	1 259	1 019	923	908	965	**	109.3
4yr annual mean	13 133	12 315	10 819	10 476	9 748	9 419	***	487.8

N.B: ***= P<0.001, **= P<0.01, *= P<0.05 and NS = not significant; SED = Standard Error of Difference.

Lucerne measurement

Seasonal production measurements for the lucerne were taken after the first year of establishment (Table 2). To do this, 10 capacitance readings (Nichols 1973) were taken per plot. The mean of these was then used to locate a 0.2 m^2 quadrat to be harvested. When the plant material was too tall for the capacitance meter (0.4 m), yield was determined by cutting a 0.75 x 8.0 m strip at 30 to 50 mm height through the plot using a sickle bar mower. The fresh weight was weighed and a subsample taken, dried, and weighed, to enable dry matter (DM) yield per hectare to be calculated.

After each production measurement, the remaining herbage was grazed off, using sheep (300 to 400 su/ha) for two to four days. Post-grazing, plots were evenly trimmed above crown height with the sickle bar mower. Lucerne production measurements were taken when 10% of the crop was flowering, or when another flush of basal shoots was visible on the crown. This gave six to eight harvests per year. Production cuts began in October 1982, one year after sowing, and continued until May 1987. Prior to the final production measurements, additional data on plant density, crown size, number of shoots per crown, and height of exposed crowns were recorded. Plant population was estimated by randomly placing a meter square quadrat 10 times within each plot, and counting the number of plants within each quadrat. A random selection of 35 plants along a diagonal transect placed through each plot were measured for crown size, the number of shoots per crown and height of the exposed crown.

Modelling

To assess the possible role of lucerne in summer dry hill country, we used the Stockpol computer model (Marshall *et al.* 1991).

Results and discussion

Comparison of lucerne against pasture

The average annual dry matter production over five years was highest for 'Rere' lucerne and lowest for WL514 (Table 2). Details of the changes in yield over time for each cultivar are summarised in Table 2. Overall annual production was consistent across years, and differences among cultivars were minor compared with between seasons. For example, 'Rere' usually produced 0.9 to 2 t/ha more lucerne than 'Saranac' in spring and summer. However, for all cultivars, summer production was highest (at least twice that in autumn), and winter production was lowest. Over all years, 'Rere' was the highest yielding cultivar and the least variable (CV=4.2%), so yield results of 'Rere' were used in comparison with pasture (CV=7.2%) in the systems modelling section of this study (Table 3).

Table 3 Seasonal dry matter production of 'Rere' lucerne compared with pasture grown on a north facing slope (20º) at Whatawhata from 1982 to 1987.

	Rere		Pasture	
	Mean yield (kg DM/ha)	C.V. (%)	Mean yield (kg DM/ha)	C.V. (%)
Spring	3 949	15.6	4 770	4.5
Summer	5 454	10.4	3 390	26.1
Autumn	2 082	36.6	2 000	29.8
Winter	1 457	13.1	2 010	7.9
Annual	13 133	4.2	12 170	7.2

NB: C.V. = Coefficient of variation

The seasonal patterns of 'Rere' were different from those of pasture (Figure 1). 'Rere' lucerne grew faster (62 kg DM/ha/day) than pasture (34 kg DM/ha/day) during the summer, as it produced 62% more forage. However, lucerne grew slower than pasture through winter until the end of spring (June to November). Over the five years, DM production of 'Rere' was more consistent than pasture in summer, but more variable in the other three seasons (Table 3).

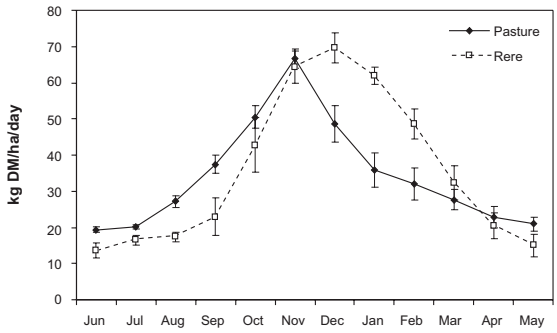

Figure 1 Mean monthly growth rates of pasture and 'Rere' lucerne grown on hill country (20° slope) at Whatawhata over five years (1982–1987). NB: Error bars indicate standard error of the mean.

Persistence of lucerne

Lucerne performed well growing on the hill side despite intensive grazing by sheep (300 to 400 su/ha) and partial exposure of the crowns due to movement of soil down hill (Table 4). The grazing and soil movement away from the crowns measured by mean height of crown exposure does not appear to have had a detrimental effect on the production of the lucerne over the five years of the study. There was no correlation between plant density, crown size or shoot proliferation.

Table 4 Lucerne plant number and crown morphology of six lucerne cultivars after 5 years on a hill country (20° slope) site at Whatawhata.

Cultivar	Rere	WL318	Saranac	P521	AS13R	WL514	SED
Mean plants/m^2	10.1	11.3	7.6	10.2	12.1	5.4	0.75
Mean crown diameter (cm)	10.7	10.5	10.9	11.2	9.6	11.9	0.66
Mean no. of shoots/crown	30.8	34.1	31.4	37.0	28.6	40.9	3.31
Mean height of crown exposure (mm)	14.8	18.8	20.7	21.1	21.6	21.3	1.64

NB: SED = Standard Error of Difference

Modelling lucerne production

Stockpol was used in this study because it essentially models a whole farm system as described by Marshall *et al.* (1991) taking into account animal numbers, weight gains, sales, purchases, deaths, and reproductive performance. On the pastures side, pasture growth was modified according to pasture cover as mass. The model determines if there was enough feed to meet the requirements of the animals. If at any time there was less feed available to the livestock than they require to meet the performance targets set, then the model becomes infeasible.

A model was built in Stockpol of a typical North Island summer dry sheep and beef hill farm based on the MAF model farm (Anon. 2002), which was an amalgamation of MAF monitor farms.

The MAF model farm was 500 ha with 375 ha steep and 125 ha of flat-rolling contour. Dry matter production on the steep land was derived from a typical dry hill farm in summer from within the Stockpol database, while that of the easy country was based on the growth rates measured in this study (Figure 1). Stockpol was used to reconcile the average pasture growth rate for the whole farm to the stocking rate as described in the MAF model. Using Stockpol to derive the best financial outcome, the optimum area of lucerne required on the farm was determined. This took into consideration the impact on winter feed supply and the amount of additional high quality feed available in the summer. The area of lucerne had to meet lamb live weight gain targets, and lift ewe mating weights. A higher lambing percentage would improve the utilisation of the additional summer feed provided by the lucerne. Webby and Sheath (2002) found that typically the inclusion of high value forages into a farm system must be matched with changes to the system to capture the full value of the additional feed.

In this model farm, by sowing half of the easy country (62.5 ha) in 'Rere' lucerne, the model predicted that the gross margin would be improved by 3% ($18.50/ha; (Table 5). This was achieved by increasing the lambing percentage from 116 to 136, and increasing sale weight of lambs from 15.5 kg to 18 kg. Farmers should look to working out the best ratio of lucerne to pasture for their system.

Table 5 Modelled farm performance (2002).

	Pasture	12.5% lucerne 87.5% pasture
Lambing (%)	116	136
Stocking rate (su/ha)	10.6	9.8
Lamb sale weight (kg)	15.5	18.0
Lucerne establishment and maintenance ($/ha)	N/A	41.50
Gross margin ($/ha)	611.00	629.50

NB: All performance figures are based on per ha over the whole farm.

Conclusions

1. Lucerne was easily established and maintained for 5 years on hill country despite intensive sheep

grazing and the movement of soil away from the crowns.

2. In the summer months, 'Rere' lucerne production was significantly higher than pasture production.
3. The modelled 500 ha farm showed a predicted gross margin increase of 3% when half of the 125 ha of easy country was planted in lucerne.

ACKNOWLEDGEMENTS

We would like to thank the staff at Whatawhata Research Centre for their technical assistance. Special thanks go to Martin Upsdell, our biometrician.

REFERENCES

Anon. 1954. Yellow brown loams. pp 132. *In*: General Survey of the Soils of North Island, New Zealand. Soil Bureau Bulletin (ns) 5, Wellington.

Anon. 2002. Hawke's Bay/Wairarapa summer dry. pp 30-37. *In*: Sheep and Beef Monitoring Report. Ministry of Agriculture and Forestry, Wellington.

Cornforth, I. S.; Sinclair, A.G. 1984. Soil Testing. *In*: Fertiliser and Lime recommendations for pastures and crops in New Zealand. 9pp.

Dunbier, M.W.; Easton, H.S. 1982. Cultivar development. pp 117-120. *In*: Lucerne for the 80s. Special Publication No.1. Ed. Wynn-Williams, R.B. Agronomy Society of NZ, Christchurch.

Marshall, P.R.; McCall, D.G.; Johns, K.L. 1991. Stockpol: A decision support model for livestock farms. *Proceedings of the New Zealand Grassland Association* 53: 137-140.

Nichols, G. De La M. 1973. Pasture yield instrument using a radio frequency bridge. *Journal of British Grassland Society* 28: 27-30.

Waghorn, G.C.; Barry, T.N. 1987. Pastures as a nutrient source. pp. 21-37. *In*: Livestock feeding on pasture. Ed. A.M. Nicol. NZ Society of Animal Production, Hamilton.

Webby, R.W.; Sheath, G.W. 2000. The impacts of change in forage quality and seasonality on sheep farm profitability. *Proceedings of the New Zealand Grassland Association* 62: 189-194.