Hill country farm investment options – cocksfoot pasture vs. superphosphate fertiliser

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Abstract

Farmers can choose between investment in pasture species or fertiliser, however, there are few comparisons of these options. This paper reports on the effects of 'Grasslands Wana' cocksfoot, (*Dactylis glomerata* L.) introduction and superphosphate application on pasture production in hill country. The effects of pasture production on bull-beef production were subsequently modelled using Stockpol®. Pasture, bull and financial performance was measured within four self-contained farmlets (each approximately 9 ha) at the AgResearch Ballantrae Hill Country Research Station; half of two farmlets had been oversown with Wana in autumn 1992 and two farmlets were untreated "Resident" hill pasture. The Wana farmlets generated an average $42.80/ha greater income than Resident farmlets. On average, modelling with Stockpol found gross financial return was increased by 80% by application of 40 kgP/ha ($715.26/ha) compared to nil fertiliser ($397.84/ha). With a cost of fertiliser of $2.44/kgP applied ($97.60) this predicted return was highly profitable. If the establishment costs of Wana were spread over the life of the pasture economic responses would be greater from investment in Wana cocksfoot, however, in the short term, economic responses were greater from investment in fertiliser. In the medium term a combination of investment in Wana establishment and fertiliser input would likely maximise the economic return.

Keywords: bull beef, *Dactylis glomerata* L., farm system, 'Grasslands Wana' cocksfoot, Stockpol®, superphosphate

Introduction

Among the options for farm investment are pasture species introduction and fertiliser application. Parminter (1991) modelled the economic return from capital fertiliser application or 'Grasslands Wana' cocksfoot (*Dactylis glomerata*) introduction, and found a similar payback period (7–8 years) for both investment options. Detailed comparison between these investment options in hill country, however, is complicated by there being relatively little biological information on the relative differences in the responses of pasture and animal production to these farm inputs.

Wana cocksfoot is particularly productive and persistent on sunny aspects in low to moderate fertility hill country. Pasture yield responses of up to 40% greater than resident pastures have been reported for Wana introduction (Barker *et al.* 1985, 1993). Webby *et al.* (1990) calculated that greater production from Wana cocksfoot in hill country could be worth up to $125/ha, but concluded however, that establishment failure and inconsistent responses of other pasture species made wide-spread use of new pastures in hill country of questionable value. Previous modelling with Stockpol® has found that where establishment of Wana increased total pasture production, increased animal and financial performance can be expected (Parminter 1991; Barker & Baars 1993), however, no system trials have been done to show the benefits for animal production.

In contrast to pasture species performance, animal responses to fertiliser application in hill country have been shown at a system scale (Lambert *et al.* 1983; Clark *et al.* 1986). Responses to superphosphate vary but include 44, 55, 78 & 91 kgDM/kgP (Ledgard *et al.* 1992; Gillingham *et al.* 1990; O'Connor *et al.* 1990; Lambert *et al.* 1983, respectively). Barker *et al.* (1993) found in dry Wairarapa hill country that Wana had a greater annual yield response (+39%) to fertiliser (50 kgN/ha and 34 kgP/ha) than four other species, suggesting a positive interaction of cocksfoot and fertiliser use might benefit animal production.

Stockpol is a farm system model that allows the effects of variations in farming enterprise and farm inputs on animal performance and farm profitability to be predicted (Marshall 1991). Stockpol is a useful tool for predicting animal and financial responses *in lieu* of having to complete farm-scale experimentation.

This paper reports on a trial which tested the hypotheses that (a) introducing a more productive grass species (Wana cocksfoot) would increase animal (bull-beef) production in hill country, and (b) this introduction was cost-effective compared to the return expected (through modelling with Stockpol) from investment in phosphate fertiliser application.

Methods

Site, trial design and treatments

Two self-contained farmlets (each approximately 9 ha) had the north- and west-facing slopes (about 50% of farmlet area) aerially oversown with lime-coated Wana cocksfoot (22 kg/ha) following defoliation with 2 L/ha glyphosate, at the AgResearch Ballantrae Hill Country Research Station in autumn 1992. By 1995 the Wana pastures had an average contribution to yield of 15–45% from cocksfoot and 12% from white clover (*Trifolium repens*). Another two farmlets were untreated "Resident" hill pasture, comprising browntop (*Agrostis capillaris*)-dominant pasture with an average 15% contribution of white clover to pasture yield. The soil was dominantly a Taihape steepland soil, a yellow-grey earth and yellow brown earth intergrade derived from sandy siltstone (Pallic Orthic Brown Soil, Typic Eutrochrept) (J.D. Cowie and R.H Wilde pers. comm.). The trial area had been fertilised with 150 kg DAP/ha for 5 years, and had an initial Olsen P status of 15 µgP/g soil. Long-term rainfall was 1200 mm/year, and was drier than average during winter 1997 and autumn 1999.

A paddock-scale fertiliser trial was initiated within the grazing trial in June 1997. Three levels of P (0, 20 & 40 kgP/ha as superphosphate, 0-9-0-12) were applied in replicate to six 0.5 ha paddocks within each farmlet, i.e., 24 paddocks in total. The high P treatment (P40) also received an initial capital dressing of 60 kgP/ha in June 1997. Within each farmlet, the bull grazing rotation was always in order of increasing fertility. There was an additional paddock of each of P0 and P40 to remove effects of nutrient transfer, but no measurements are reported from these paddocks. Within each farmlet, since the bulls grazed all fertiliser treatments during their grazing rotation, animal growth could be not ascribed to specific fertiliser treatment. Areas outside the fertiliser trial continued to receive DAP-13S (13-16-0-13) at 150 kg/ha/yr.

Animal management

The farmlets were stocked with weaned cross-bred bulls of mixed beef breeds in autumn each year and rotationally grazed within their respective farmlets for up to 10 months, when they were sold for slaughter at approximately 500 kg. Grazing was prescribed by experienced bull farmers affiliated with the trial; the stocking rate and grazing management aimed to ensure pasture mass did not exceed 2300 kgDM/ha (2600 kgDM/ha in summer). Sheep were added to each farmlet to control surplus pasture (usually starting in December), to simulate the increased animal demand that occurs in a traditional breeding system. Sheep were also added to each farmlet as bulls were removed for slaughter (usually in January and February), to ensure continuity of grazing and to control ragwort. Sheep and cows grazed the farmlets once bulls were sold for slaughter (usually during March) to 'clean-up' pasture before the next season bulls. Bull drenching and mineral supplementation was according to accepted farm practice.

Measurements

Pasture growth rate was measured from two pre-trimmed 0.5 m^2 exclosure cages per paddock between June 1997 and May 1999 (48 cages in total), cutting when pasture reached an average 2500 kgDM/ha. Seasonal yield was calculated by apportioning harvests on an average daily gain basis to 3-month periods, with autumn = March–May. Pasture composition was measured by manual dissection of subsamples from each harvest. Unfasted bull liveweight was measured each month during 1997–98. Slaughter data and financial returns were provided by the freezing works in autumn 1998. Other stock were valued in proportion to their grazing period at a gross margin of $35/stock unit/yr.

Statistical analysis

Pasture growth rate data were analysed as a split plot design, with two replicates of two pasture-types (Wana, Resident) as main plots, and three levels of phosphate (0, 20 & 40 kgP/ha) as sub-plots (paddocks). Seasonal growth calculations were transformed ($x^{1/2}$) before analysis of variance using the Statistical Analysis System (SAS) and back-transformed means are presented in Table 1.

Table 1 Mean seasonal and annual pasture yield for 1997–99, for two pasture types and three phosphate treatments, under bull grazing in hill country (3-month seasons; autumn = March–May).

Treatment	autumn	winter	spring	summer	total
Resident	1310	1480	3270	1210	7350
Wana	1650	2070	4400	1440	9600
	+26%	+40%	+35%	+19%	+31%
Pr>F	ns[1]	0.055	0.032	ns	0.002
no phosphate	1330	1430	3560	1250	7620
20 kgP/ha/yr	1320	1740	3760	1210	8090
40 kgP/ha/yr	1800	2150	4130	1520	9660
	+36%	+50%	+16%	+22%	+27%
Pr>F	0.077	0.012	ns	0.052	0.013

[1]Pr>F exceeded 0.1

Modelling

Modelling was completed in two phases using the farm system programme Stockpol (Marshall 1991).

In the first (validation) phase, use of Stockpol was validated using actual pasture and bull growth measured during 1997–98 to achieve a feasible (as defined by Stockpol) result for the Resident and Wana farmlets. Model assumptions matched actual practise as closely as possible. Weaned 270 kg cross-bred bulls were purchased in May, grown for 9 months and sold for slaughter at 530 kg liveweight (Figure 1). After February, all remaining bulls were sold, those above 450 kg sold for slaughter and those below 450 kg sold store. Prices modelled were the schedule prices paid during January and February 1998 ($1.95–$2.40/kg carcass-weight). The model assumed 100 ha farms, with the Wana farmlets stocked with 212 bulls and 1500 ewes during autumn, and the Resident farmlets stocked with 201 bulls and 1200 ewes during autumn.

The second (prediction) phase modelled 4 hypothetical farms (Wana-no phosphate, Wana-40 kgP/ha, Resident-no phosphate, Resident-40 kgP/ha) using the same model assumptions as for the validation phase (above). The number of bulls and sheep was predicted from pasture growth measured within the fertiliser trial (Table 2) (assuming similar pasture cover as during the validation phase), using the "modify" option of Stockpol.

Figure 1 Average unfasted liveweight of bulls from two pasture-type treatments during 1997–98 (72 bulls in total). Each point was the average of two mobs (replicates).

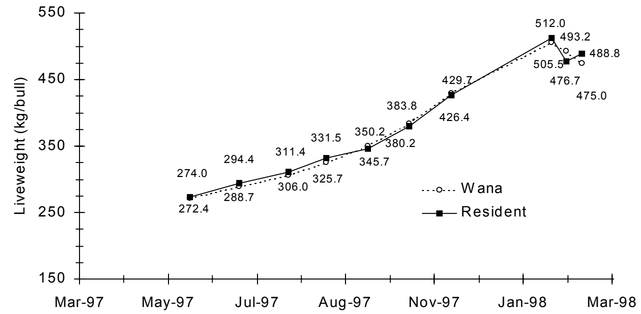

Table 2 Pasture growth rate (kgDM/ha/d) calculated from measured production, and total annual yield (kgDM/ha) used for modelling with Stockpol.

Month	Resident No P	Wana No P	Resident 40 kgP/ha	Wana 40 kgP/ha
Jul	10	12	15	20
Aug	11	16	16	21
Sep	22	30	26	35
Oct	30	34	35	40
Nov	32	36	35	40
Dec	30	30	28	35
Jan	22	25	28	30
Feb	20	21	23	25
Mar	18	20	20	22
Apr	15	20	16	20
May	11	16	15	18
Jun	10	14	12	16
Annual total	7022	8330	8263	9781

Results and discussion

Pasture type

Consistent with previous studies (Barker *et al.* 1985, 1993), pasture growth during 13 June 1997 to 14 May 1999 averaged 31% greater on Wana pastures than for resident pastures with the response being greatest during winter (Table 1). Since Wana pastures only contributed to half the farmlet area, the benefit to Wana farmlets was halved (15%). During 1997–98, although the stocking rate of Wana farmlets was 6% greater than Resident farmlets, bulls had similar liveweight between pasture types (Figure 1). Farmlets were also grazed with sheep and cows during autumn. In 1997–98, this grazing averaged 3.9 SU/ha on Wana farmlets and 3.5 SU/ha on Resident farmlets. During 1997–98 the Wana farmlets generated an average $42.80/ha greater income than Resident farmlets. This was similar to the average $39.18/ha greater income from Wana farmlets than Resident farmlets for the previous 4 years, and shows the relevance of the result presented for 1997–98.

At the level of financial return measured, and for a cost of $138/ha of system developed ($275/ha oversown), 8% interest on capital and $60/ha for grazing costs in the establishment winter, the period to break-even financially from Wana cocksfoot oversowing was 8 years. This was an almost identical result to a similar calculation by Parminter (1991).

Fertiliser

The fertiliser treatments resulted in a gradient of P status, with 0, 20, and 40 kg P/ha resulting in an Olsen P status of 17.9, 24.2 and 29.5 µP/g soil in October 1997. The pasture yield response to added P averaged 51 kgDM/kgP. This was similar to 44, 55, 78 & 91 kgDM/kgP reported by Ledgard *et al.* (1992), Gillingham *et al.* (1990), O'Connor *et al.* (1990), Lambert *et al.* (1983), respectively. The larger responses were from longer-term trials where fertiliser from previous years contributed to the measured response. There was no statistically significant interaction between pasture type and fertiliser level, showing that Wana and resident pastures had a similar response to superphosphate.

Modelling

Stockpol was able to model the Wana and Resident bull systems, with a good agreement between the measured and modelled data. On average, modelling with Stockpol found gross financial return was increased by $67/ha by establishment with Wana cocksfoot (Table 3), this was similar to the $42.30 actually observed. No adjustment was made for pasture quality, since Wana- and browntop-based pastures have similar quality (Barker & Baars 1993).

On average, modelling with Stockpol found gross financial return was increased by 80% by application of 40 kgP/ha ($715.26/ha) compared to nil fertiliser ($397.84/ha) (Table 3). With a cost of fertiliser of $2.44/kgP applied ($97.60) this predicted return was highly profitable.

Table 3 Number of bulls, number of ewes and gross financial return per ha (for sheep, bulls, and total (less animal health)) predicted by Stockpol. The 'modify' option of Stockpol was used to determine the maximum number of bulls and ewes given pasture growth in Table 1.

Pasture type	fertiliser	Number of bulls/ha (May–Jan)	Number of ewes/ha (Jan–Mar)	$/ha (bulls)	$/ha (sheep)	$/ha (total)
Wana	nil	1.39	9.9	$394.99	$ 49.40	$433.27
Wana	40 kgP/ha	2.40	15.0	$691.78	$ 75.00	$747.58
Resident	nil	1.08	6.4	$331.27	$ 57.78	$362.41
Resident	40 kgP/ha	2.01	12.0	$591.02	$108.00	$682.94

Conclusion

Investment in either Wana cocksfoot establishment or fertiliser application resulted in a net financial benefit. In the case of Wana cocksfoot, biological responses did not occur until the second year after investment (establishment) and if the costs of interest were included, the cash investment was not returned until 8 years. Wana pastures are known to persist for 20 years so financial benefits would continue beyond the 'break-even' period. Among the benefits to Wana establishment was greater management flexibility in being able to finish animals to 500 kg liveweight sooner than for resident pastures. There are significantly greater risks of establishment failure in the establishment period than in obtaining the observed fertiliser response. If the establishment costs of Wana could be spread over the life of the pasture, economic responses would be greater from investment in Wana cocksfoot, however, in the short term, economic responses were greater from investment in fertiliser. In the medium term a combination of investment in Wana establishment and fertiliser input would likely maximise the economic return.

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REFERENCES

Barker, D.J.; Lancashire, J.A.; Meurk, C. 1985. 'Grasslands Wana' cocksfoot – An improved grass suitable for hill country. *Proceedings of the New Zealand Grassland Association 46*: 167–172.

Barker, D.J.; Baars, J.A. 1993. Comparing the seasonal productivity of cocksfoot and resident pastures on hill country farms using a system-model. *Proceedings of the New Zealand Grassland Association 55*: 81–85.

Barker, D.J.; Lambert, M.G.; Dymock, N.; Gray, Y.S. 1993. Introduction, production and persistence of five grass species in dry hill country 5. Central Wairarapa. *New Zealand journal of agricultural research 36*: 29–39.

Clark, D.A.; Lambert, M.G.; Grant, D.A. 1986. Influence of grazing and fertiliser management on North Island moist hill country. 5. Animal production. *New Zealand journal of agricultural research 29*: 407–420.

Gillingham, A.G.; Richardson, S.; Power, I.L.; Riley, J. 1990. Long-term effects of withholding phosphate application on North Island hill country: Whatawhata Research Centre. *Proceedings of the New Zealand Grassland Association 51*: 11–16.

Lambert, M.G.; Clark, D.A.; Grant, D.A.; Costall, D.A. 1983. Influence of grazing and fertiliser management on North Island moist hill country. 1. Herbage accumulation. *New Zealand journal of agricultural research 26*: 95–108.

Ledgard, S.F.; Thorrold, B.S.; Sinclair, A.G.; Rajan, S.S.S.; Edmeades, D.C. 1992. Summary of eleven long-term field trials with 'Longlife' phosphatic fertiliser. *Proceedings of the New Zealand Grassland Association 54*: 35–40.

Marshall, P.R. 1991. Stockpol: A decision support model for livestock farms. *Proceedings of the New Zealand Grassland Association 53*: 137–140.

O'Connor, M.B.; Smart, C.E.; Ledgard, S.F. 1990. Long-term effects of withholding phosphate application on North Island hill country: Whatawhata Research

Centre. *Proceedings of the New Zealand Grassland Association 51*: 21–24.
Parminter, T.G. 1991. Financial evaluation of hill pasture improvement. *Proceedings of the New Zealand Grassland Association 53*: 117–121.
Webby, R.W.; Sheath, G.W.; Boom, C.J. 1990. Performance of new pasture cultivars in a hill country finishing system. *Proceedings of the New Zealand Grassland Association 51*: 151–156.

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