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An evaluation of the Stockpol™ model

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ABSTRACT

The Stockpol model was designed for decision support on New Zealand sheep and beef cattle farms. It indicates the biological feasibility of a livestock system and provides the opportunity for users to test alternative livestock policies. An evaluation of the Stockpol model was made using 44 data sets from farmlet trials at Gore, Ballantrae and Whatawhata Research Centres and data from Massey University's Riverside farm in the Wairarapa. These data covered a range of sheep and beef finishing systems. The main test compared the measured pasture growth rate with that required by Stockpol to predict the monthly pasture cover recorded in the data. Measured and required pasture growth rates differed significantly (<0.01) in July, August and September. The model was conservative and required an average of 5.1 kgDM/ha/day more growth over these months than was measured. In other months differences were small and non significant. When animal demand was adjusted to mimic pasture cover, adjustments of minus 22% from July to September were required. Overall it was considered that Stockpol can be used with confidence for analysing options for farmer decision making. Areas for further improvement of Stockpol have been defined as the pasture growth model in early spring. Aspects of the animal demand in early spring also need to be tested more vigorously. The evaluation emphasised the importance of consistent input data for use in models. For example, the pasture measurement technique was different at each of the four sites studied. This may explain some of the variation between predicted and measured data.

Keywords: decision support; livestock policy; feed supply; pasture cover; feed demand.

INTRODUCTION

The Stockpol model (Marshall *et al.*, 1991) was developed to improve the transfer of information about alternative livestock policies to New Zealand sheep and beef cattle farmers. The model indicates the biological feasibility of a livestock system and provides the opportunity for users to evaluate the economics of alternative livestock policies. During its development the model has been regularly updated through feed back from users, but it has not been formally tested against scientific data. This paper reports on an evaluation of the accuracy of Stockpol to determine the confidence that users can have in the model as a decision support tool. The aim of the evaluation process was to define the model's strengths and weaknesses in predicting biological outcomes. Model predictions were evaluated against measured data sets obtained at the Gore, Ballantrae and Whatawhata Research Centres and Massey University's Riverside farm.

The Stockpol model

Stockpol was developed at Whatawhata Research Centre and has been used by Agriculture NZ and Wools of NZ farm consultants since 1991. It is operated by first defining a farm with a number of information inputs. The farm system is then tested for feasibility: i.e. is pasture accessibility and supply sufficient to meet animal performance targets?. A farm can be modified to make it feasible, or to 'optimise' one that is already feasible. Features of Stockpol are more fully described in Marshall *et al.*, (1991).

Model Operation

The basis of Stockpol is essentially a feed budget equation that updates pasture cover by deducting daily animal intake and adding the net accumulation of pasture. Pasture growth and animal intake components of this equation are derived within the model from input pasture growth rate and animal performance data. The daily feed demand (MJME) required for the specified levels of performance is calculated for each stock class. These are combined to give the total daily demand for all animals during half month time steps. Feed demand is converted into units of dry matter using MJME/kgDM values derived within the model. Calculations are then performed to determine if animal intake of pasture would be constrained by the amount of pasture cover on the farm. The maximum demand supported each day is calculated using an intake multiplier, which indicates the proportion of the potential intake that each stock class can reach, given the actual pasture cover. Constrained and desired demand are then compared. The lower of these estimates is used as the animal intake for the day unless average intake for the month to date is lower than the desired demand. Under this condition the greater of the two estimates is used as the animal intake. If actual intake is lower than the desired demand over a period of a month, the stock policy is declared biologically infeasible.

Pasture growth is a function of potential growth, pasture cover and decay rates. Potential pasture growth rate data are assumed to have been obtained using the double trim cutting (Radcliffe 1974) standard rate of growth technique (ROG). These are modified by a multiplier to account for effects of pasture cover on pasture growth rates.

Pasture growth is then divided between green, dead and stem tissue pools. The proportion allocated to each pool is determined by the time of year to reflect the percent of green, dead and stem in the sward. Over the summer-autumn periods

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increased amounts are allocated to the dead pool and this increases further if pasture cover levels exceed 2,200 kg DM/ha in late spring. Above this level a higher rate of decline in pasture quality is assumed. From March through to August pasture is decayed from the dead pool.

METHODS

Description of data used for model testing

Data were sourced from AgResearch Centres at Ballantrae (data from 8 farmlets covering a 3 year period), Gore (data from 4 farmlets over a range of years), Whatawhata (data from 12 farmlets, covering 3 years) and from Massey University's Riverside farm (data over 4 years).

In total 44 Stockpol files were formed from the data sourced. At Ballantrae the trials ended 2 months before the end of the third year so for the months of May and June only 36 files were available to complete the analysis.

Each data file contained: Map areas of the farmlet/farm in hectares; stock - breed, numbers, sales and purchases, mating, weaning and shearing dates, monthly liveweights, fleece weight and lambing percentage, plus average monthly pasture growth rates in kg DM /ha/day and monthly pasture covers in kg DM/ha.

Description by site

Ballantrae

Ballantrae data came from steep hill land, typical of cooler wetter North Island areas. Data covered the years 1989/90, 1990/91, 1991/92 from 1 July to 30 June. Treatments involved 4 wet and 4 dry ewe systems at different stocking rates (9 to 18.5 su/ha). Pasture growth rate data were obtained by exclosure cages (ROG) cut approximately 8 times a year. The data were then apportioned to monthly growth rates in kg DM/ha/day. Average pasture cover over the whole farmlet was measured each month using pasture heights obtained from a sward stick and converted to kg DM/ha by a regression equation.

Gore

These data came from an intensive sheep finishing area for a range of grazing strategies with ewes and lambs and a late lambing trial. Pasture growth rate data were derived from the difference technique which is often referred to as net accumulation rate (NAR) (Hodgson, 1979). Pasture covers were estimated by calibrated visual assessment to 1 cm height and collated for Stockpol as monthly means. To take into account the absolute pasture cover to ground level as required by Stockpol, these covers were adjusted for pasture mass below 1 cm. This was done from data on pasture mass below a mower height of 2.5 cm (Cossen, unpublished) and assuming 65% of the pasture mass below 2.5 cm was in the 0 - 1 cm zone (Webby and Pengelly 1986).

Riverside

Riverside farm is a commercial mixed livestock production unit located on the upper Opaki plains in northern Wairarapa. The total area is 650 hectares, 480 ha of the farm is flat, 190 ha is rolling hill country and 50 ha is steep land. The farm winters 6,800 Romney sheep and runs bull beef and dairy heifers. Four years data (1987 to 1991), were used in the Stockpol tests. Pasture growth information was collected monthly using exclosures cages and the standard double trim ROG technique. Pasture cover was recorded on either a two weekly or monthly basis using the Ellinbank Pasture Metre (EPM) on each paddock of the farm. Calibration cuts were used initially to establish a single equation for converting compressed sward height data into kgDM/ha (Parker 1985).

Whatawhata

These data came from a trial on summer dry North Island hill land which compared outputs from breeding ewes, lamb and bull finishing with two lambing dates and two pasture types (Sheath *et al.*, 1990, Webby *et al.*, 1990). The data were combined across farmlets to form a comparison of early versus late lambing during 1987/88, 1988/89 and 1989/90 .

Pasture growth information was in the form of NAR except in spring where exclosure cages were used on set stocked areas. Monthly pasture covers were derived by taking an average of the pre-post grazing herbage mass measurements for the month. These data correlated well (not significantly different) to the actual covers that were measured 4 or 5 times a year.

Evaluation procedure

The model was configured as a feed budget equation for the evaluation (Equation 1) so that the feed demand and supply components could be evaluated. Accordingly, the pasture cover constraints on animal intake were relaxed so that intake equalled demand.

$$PC_t = PC_{t-1} - I_t + G_t \qquad (1)$$

where I_t = animal intake at time $_t$ (constrained to equal animal demand at time $_t$), G_t = net pasture growth rate (a function of potential growth and pasture cover), PC_t = pasture cover.

The evaluation involved two steps: In the first, a comparison was made of measured pasture growth rate and the pasture growth rate required by Stockpol to reproduce the measured pasture covers. Further adjustments were made to the model for sites with NAR pasture data (Gore and Whatawhata) to disable the functions that modify growth due to pasture cover. In the second evaluation a multiplier on the animal demand function was calculated so that the pasture covers derived by Stockpol matched those measured in the field.

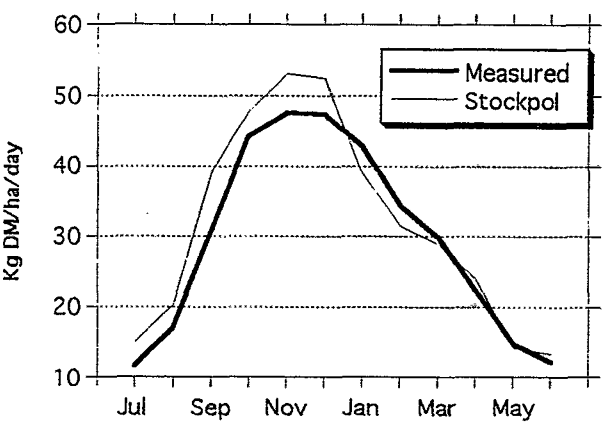
Statistical analyses were conducted to test the significance levels of differences between the measured and required pasture growth rate treatments. These analyses were done across and within sites.

RESULTS

Pasture growth rate evaluation

The measured and required monthly pasture growth rates, averaged over all sites and years, are summarised in Figure 1. The mean of the required pasture growth rates over the 44 data sets closely followed the pattern of the mean measured growth rates (Figure 1). Generally Stockpol was conservative and required slightly more pasture growth to mimic pasture cover levels from July to December than was measured. In February and March Stockpol required slightly less pasture growth than that which was measured. This could be due to insufficient decay being allowed within the model and was most noticeable at Gore, Whatawhata and Riverside. Statistical analyses (Table 1) show that the difference between required and actual pasture growth rates was significant from July to September. In these months the model suggested that pasture growth should have been between 19 and 29 % greater than the values measured. At other times of the year required and measured pasture growth rates were not significantly different.

FIGURE 1: Mean Stockpol required and mean measured pasture growth. Average of all sites.



Comparisons of measured versus required pasture growth rates for each site are given in Figure 2. The Ballantrae site stood out because Stockpol required significantly more pasture growth in spring and autumn than that which was measured. This was most noticeable in the very highly stocked treatments for both wet and dry sheep. A greater requirement for July-August and December-January pasture growth rates was a feature of the data for Gore. None of the differences at Riverside were statistically significant. At Whatawhata, measured pasture growth rates exceeded those required to predict cover levels throughout most of the year, though only those for September and March were significantly different. Differences between measured and required growth and significance levels for each site are shown in Table 1.

A point to note is that even where ROG data were available, large differences occurred in the potential rate of growth measured within each site. For example, at Ballantrae these varied across stocking rate treatments within the same year such that potential growth rates were lowest on highly stocked treatments. It is likely that the ROG estimates for the high stocked treatments incorporated reductions in pasture growth rates due to low pasture covers (ie trim heights less than 2.5 cm). This certainly happened at Whatawhata in September. Potential growth rates entered into Stockpol are modified to further reduce growth when low pasture covers occur. This effect would be most severe during spring and is most likely the reason why Stockpol required large adjustments to spring growth at Ballantrae on high stocked treatments and at Whatawhata.

Animal demand evaluation

While it was not possible to uniquely attribute differences between measured and predicted pasture cover to the animal demand or pasture growth components of the model, possible sources of error may be determined by the relative changes required to animal demand to correctly predict pasture cover (Table 2). These adjustments assume that the pasture growth model is correct and are expressed as a multiple of the animal demand calculated by Stockpol. An adjustment of 50% means animal demand needed to be halved to obtain a correct prediction, whereas an adjustment of 200% means it needed to be doubled.

Required animal demand adjustments obviously mirror the pasture growth adjustments. That is, reduced levels of animal demand would be required in the spring months compared with predicted demand. Conversely greater levels of animal demand would be required in summer and early autumn.

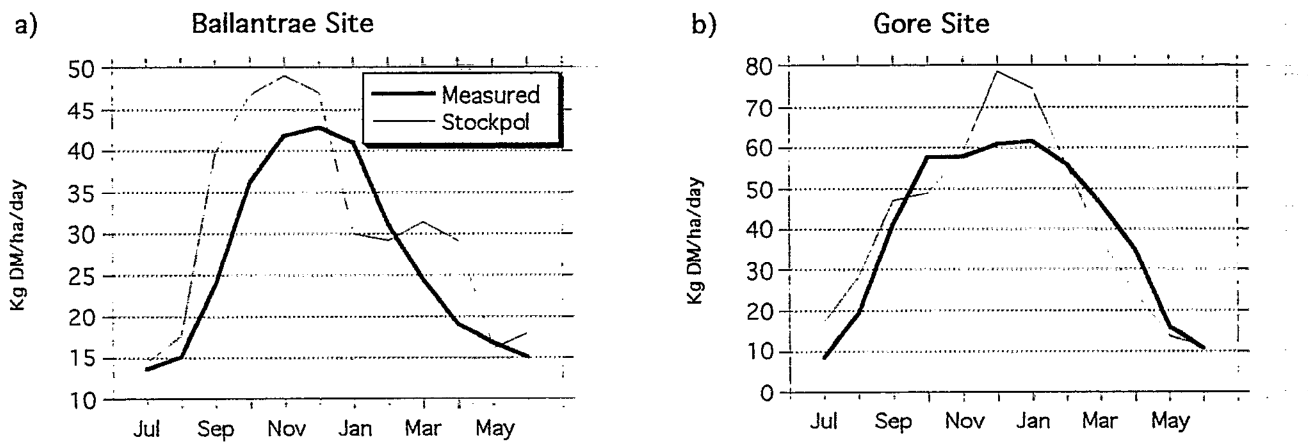
The data in Table 2 suggest that the pasture rather than the animal component of Stockpol is likely to be the major contributor to differences between measured and predicted pasture cover because very large changes to animal demand are often required to obtain correct predictions. It was considered unlikely that errors in feed demand would be this large. The spring is a time when the animal demand model is most likely to be in error due to over prediction by Stockpol. Stockpol predictions of demand are close to those found in

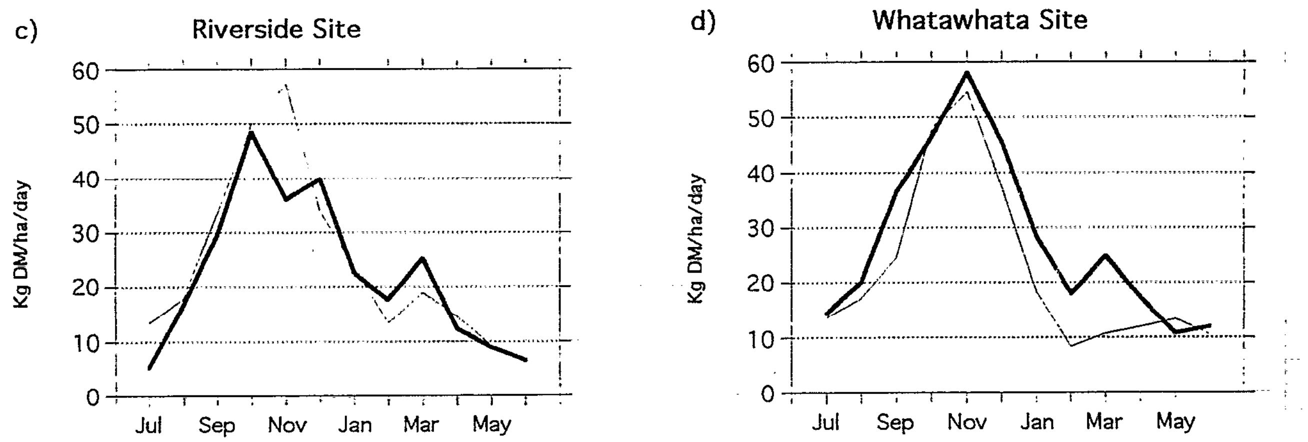
TABLE 1: Analysis of the difference between the measured and required pasture growth (kg DM/ha/day).

		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Mean all Sites		-3.4**	-3.4**	-8.5**	-3.7	-5.5	-5.0	3.8	2.7	1.0	-1.9	0.5	-1.1
Standard Error		1.1	1.2	2.3	2.6	3.0	3.4	2.8	2.0	2.3	2.2	1.1	1.0
Mean Difference - at each site	BALL	-1.0	-2.6	-15.8*	-10.5†	-7.3†	-4.2	11.0**	1.9	-7.1*	-10.2**	0.4	-1.9
	GORE	-8.8**	-9.2**	-6.1	8.8	-1.0	-17.6*	-13.0*	0.5	8.8	10.8*	2.1†	-0.4
	RIVER	-8.2†	-1.6	-3.9	-1.6	-21.2	6.0	-0.6	4.1	6.2	0.2	1.3	-1.5
	WHW	0.6	3.2	12.0*	-1.5	3.4	7.7	10.1	9.4	13.9*	5.0	-2.8	1.4
SE - at each site	BALL	1.3	1.4	2.6	3.3	4.1	4.5	3.3	2.9	2.7	2.4	1.4	1.2
	GORE	1.9	2.0	3.7	4.8	5.9	6.5	4.7	4.1	3.8	3.5	2.0	1.7
	RIVER	3.1	3.4	6.1	8.0	9.7	10.7	7.9	6.9	6.3	5.8	3.3	2.9
	WHW	2.5	2.8	5.0	6.5	7.9	8.7	6.4	5.6	5.2	4.7	2.7	2.4
Significance Levels		10%†	5%*	1%**									

FIGURE 2: Mean Stockpol required and mean measured pasture growth. Average of each site. Sites a)-b).

FIGURE 2: Mean Stockpol required and mean measured pasture growth. Average of each site. Sites c)-d).





published feed tables such as Geenty and Rattray (1987), although ewe intake data calculated from McCall *et al.*, (1986) suggests ewes may exist on less feed in early spring than is predicted from feed tables. Also at this time, the prediction of ewe energy status from liveweight is difficult because of the major fluctuation in ewe body weight due to conceptus loss.

DISCUSSION

The evaluation suggests that improvements can be made to the prediction accuracy of Stockpol in early spring through changes to the model and standardisation of potential pasture growth assessments. Continual improvement to Stockpol is linked with research aimed at enhancing our ability to predict biological outcomes on livestock farms. Never the less, studies using Stockpol have shown it to be a useful communication tool between scientists, consultants and farmer decision makers (eg. Ogle 1993, McCall and Tither 1993, and Webby 1993).

The importance of the quality of the input data in achieving accurate predictions from models such as Stockpol needs to be stressed. Pasture measurement methods at the four sites differed and this influenced the estimates of pasture production. It is important when using models to know exactly what is measured by each pasture measurement technique, relative to potential growth. While variations in technique may be of little consequence when monitoring the relative changes in pasture cover on a farm, they are important

TABLE 2: Percentage adjustments to animal demand required to derive measured pasture cover (%).

		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Site	BALL	78	43	34	45	82	92	130	140	60	43	80	105
	GORE	69	65	83	96	76	62	69	87	121	143	116	99
	RIVER	51	88	87	95	50	117	101	121	140	98	124	78
	WHW	87	121	137	73	131	143	144	141	191	102	125	98
	MEAN	71	79	85	77	85	104	111	122	128	97	111	95

when field measurements are related to model results or are used as input data for a model.

Where there is uncertainty about potential pasture production, scaling the annual production so that each stock unit is offered about 750 kg DM/year (Barlow 1985) seems to work well in practice (C.J. Korte pers comm). This corresponds well to the average annual pasture production from all files used in this evaluation of 742 ± 193 kg DM.

This study has served to provide comparisons between the model and data at the whole farm level. It was not possible to perform tests at the component level given the data available. However the authors consider that the current version of Stockpol is safe for use in livestock decision support. The area of concern with the model in early spring is a bias in a conservative direction with the model requiring more pasture growth to predict pasture cover than was measured. This means it errs on the safe side. If this conservatism proves to be a limitation in a practical situation, any bias can be rectified by the calibration facilities within the model.

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REFERENCES

Barlow, N.D. 1985. Value of sheep pasture, and the relationship between pasture production and stocking rate. *New Zealand Journal of Experimental Agriculture* **13:** 5-12.

Geenty, K.G.; Rattray, P.V. 1987. The energy requirements of grazing sheep and cattle. In: A. M. Nicol Ed. Livestock feeding on pasture. *New Zealand Society of animal Production. Occasional Publication* **10:** 39-53.

Hodgson, J. 1979. Nomenclature and definitions in grazing studies. Grass and Forage *Science* **34:** 11-18.

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

McCall, D.G.; Smeaton, D.C.; Wadams, T.K.; Gibbison, M.L. 1986. Lambing date, ewe liveweight and pasture mass effects on ewe and lamb performance during lactation. *Proceedings of the New Zealand Society of Animal Production* **46:** 129-132.

McCall, D.G.; Tither, P.M. 1993. Use of Stockpol computer decision-support program in commercial consultancy. *Proceedings of the New Zealand Grassland Association* **55:** 207-208.

Ogle, G. 1993. Temporal analysis and strategic planning for pastoral enterprises in the climatically extreme environment of the South Island high country. *In:* Economic Decision Support and Land Use Change. Proceedings of a workshop held at Landcare Research, Aokautere June 8-9, 1993. Ed P. Luckman pp 9.0-9.5.

Parker, W.J. 1985. Evaluating the Ellinbank Pasture Meter. *New Zealand Journal of Agriculture* **150 (a):** 42-44.

Radcliffe, J.E. 1974. Seasonal distribution of pasture production in New Zealand I. Methods of measurement. *NZ Journal of Experimental Agriculture* **2:** 337 - 340.

Sheath. G.W.; Webby, R.W.; Pengelly, W.J.; Boom, C.J. 1990. Finishing lambs in hill country. *Proceedings of the New Zealand Grassland Association* **51:** 181-186.

Webby, R.W.; Pengelly, W.J. 1986. The use of pasture height as a predictor of feed level in North Island hill country. *Proceedings of the New Zealand Grassland Association* **47:** 249-253.

Webby, R.W.; Sheath, G.W.; Boom, C.J. 1990. Performance of new pasture cultivars in a hill country system. *Proceedings of the New Zealand Grassland Association* **51:** 151-156.

Webby, R.W. 1993. Improving the balance of sheep and beef cattle livestock systems. *Proceedings of the New Zealand Grassland Association* **55:** 73-76.