The impacts of change in forage quality and seasonality on sheep farm profitability

R.W. WEBBY[1] and G.W. SHEATH
AgResearch Ruakura, Private Bag 3123, Hamilton
[1]webbyr@agresearch.cri.nz

Abstract

Systems planning tools were used to explore the benefits of altering the quality and seasonality of pasture supply in sheep farming enterprises. Three representative regions in New Zealand were studied; winter-cold and summer-wet (e.g., Southland, Otago and Central North Island); winter-cold, summer-dry (e.g., South Island East Coast); and winter-warm, summer-dry (e.g., North Island East Coast). Two different lamb-finishing enterprises were also analysed within each region; a conventional system where the lamb supply pattern was aligned with feed availability, and a supply contract system where more lambs were supplied for processing outside the normal season. Improving the seasonality of feed supply increased gross margins by $26 to $126 per hectare depending on the region. The greatest gains from improved seasonality occurred in the winter-cold scenarios. Improving forage quality had a more positive impact than improved seasonality changes with gross margins increasing by $53 to $148 per hectare depending on region. Overall the impact of the forage supply and forage quality changes was similar for the two lamb-finishing systems.

Keywords: lamb-finishing, pasture production, pasture quality, systems analysis

Introduction

The fine-tuning of farm systems to match the seasonal feed supply and maintain or improve feed quality is close to optimum in current New Zealand livestock systems (Webby 1993). However, the impact of further reducing the seasonality of forage supply, or improving forage quality throughout the year has not been quantified.

Our investigation explored the opportunities to improve the profitability of pasture-based sheep enterprises by improving either the seasonal supply of forage or the nutritive quality of the forage. How this can be achieved is briefly discussed, but the results of the analyses help to emphasise the direction for pasture plant breeding programmes and farm development in the future. The study focuses on the performance of a sheep enterprise and includes the adaptations of three lamb-finishing systems that can be related to the sheep farming regions of New Zealand. Included are simulations of supplying lambs to contracts outside the normal slaughter seasons.

Methods

The analyses were carried out using the Stockpol computer model (Marshall *et al.* 1991) and two spreadsheet models. They covered three regions that represent most of the sheep farming area of New Zealand (see climatic descriptions in Table 1).

Table 1   Climatic descriptions of the representative regions (long-term annual averages from the New Zealand Meteorological Service).

	Sunshine hours	10 cm soil temp (°C)	Air temp	Rainfall range (mm)
Region 1	1595	9.0	9.7	900–1300
Region 2	1900	11.0	11.7	500–750
Region 3	1950	11.8	12.1	600–1000

Region 1: winter-cold, summer-wet e.g., Southland, Otago, Central NI
An intensive breeding and lamb-finishing system typical of Southland/Otago sheep-only farming was adapted to represent this region. The sheep breed used was Coopworth and rams joined the ewes on 20 April. The farm area was 200 ha and the supplementary feed was baled silage. For the contract supply analysis, all surplus ewe lambs and the lighter one-third of the male lambs were sold in June, July and August. The performance levels set (as modelled) are shown in Table 2. The forage supply assumed for Region 1 is shown in Figure 1 and annual pasture production was 12 600 kg DM/ha/year.

Region 2: winter-cold, summer-dry e.g., SI East Coast
A lamb-finishing system, typical of Canterbury dryland farming was adapted to represent this region. The dam breed was assumed to be Coopworth, with two-tooth ewes brought in as replacements. A Suffolk ram was used as a terminal sire joining the ewes on 17 March. The farm area was set at 300 ha and hay was the

Table 2   Livestock performance for Region 1 (winter-cold, summer-wet).

System	Stock units per ha	Ewe mating wt (kg)	Lamb weaning wt (kg)	Lambing (%)	Wool (kg/ha)
Conventional					
Base	15.8	65	31.8	130	94
Seasonality	15.8	70	33.9	144	102
Quality	15.8	70	33.9	144	105
Contract					
Base	17.5	65	31.9	130	77
Seasonality	18.0	70	33.9	144	81
Quality	18.0	70	33.9	144	81

Figure 1   Pasture growth profiles by region for base (—) and improved (- – –) seasonality scenarios.

supplementary feed type. The contract system supplied lambs in October (where possible), November and December. On average lambs were supplied about 1 month earlier than the conventional system. The performance levels set are shown in Table 3. The forage supply assumed for Region 2 is shown in Figure 1 and annual pasture production was 8000 kg DM/ha/year.

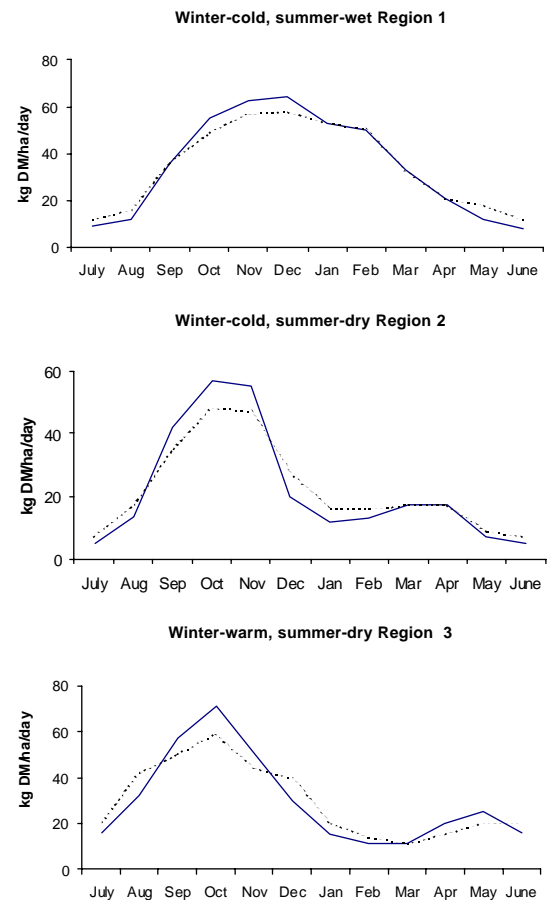**Table 3**   Livestock performance for Region 2 (winter-cold, summer-dry).

System	Stock units per ha	Ewe mating wt (kg)	Lamb weaning wt (kg)	Lambing (%)	Wool (kg/ha)
Conventional					
Base	10.4	60	30.0	130	45.6
Seasonality	10.4	65	32.3	135	48.2
Quality	10.4	65	32.3	135	46.4
Contract					
Base	9.4	60	30.1	130	39.7
Seasonality	9.4	65	33.6	135	41.7
Quality	9.4	65	33.2	135	40.0

Region 3: winter-warm, summer-dry e.g., NI East Coast

The system used was typical of a Hawke's Bay dryland lamb-finishing enterprise using a mix of breeds (Coopworth base) and the ram joining on 1 March. The farm area was set at 300 ha and the supplementary feed was baled silage. Lambs were supplied on contract in October, November and December. Sheep performance levels are described in Table 4. The forage supply for region 3 is shown in Figure 1 and annual pasture production was 10 800 kg DM/ha/year.

Pasture growth data for each region were sourced from within the database of Stockpol (Lambert *et al.* 1984; Hayman & McBride 1984; Radcliffe 1974 & 1975) and the base forage supply for each representative farm was modified to:

a. Reduce the seasonality of forage supply: where distinct winter (May–August) and summer (December–February) production troughs existed,

Table 4   Livestock performance for Region 3 (winter-warm, summer-dry).

System	Stock units per ha	Ewe mating wt (kg)	Lamb weaning wt (kg)	Lambing (%)	Wool (kg/ha)
Conventional					
Base	11.9	65	25.9	133	44
Seasonality	11.9	65	25.9	133	44
Quality	11.9	70	28.4	144	46
Contract					
Base	11.9	65	21.8	133	43
Seasonality	11.9	65	21.8	133	43
Quality	11.9	70	24.3	144	45

base pasture growth was increased by 33%; and production during peak growth months was reduced to generate an annual production level similar to the base system.

b. Increase forage quality: the level and pattern of pasture growth of the base systems was retained,

but the pasture quality patterns within Stockpol were assumed to increase from November to April over the base system. The increase was 1 Mega Joule (MJ) of metabolisable energy (ME) per kilogram of dry matter (kg DM) (Ulyatt *et al.* 1995) and the maximum value was limited to 11.5 MJ ME/kg DM. This constraint was set to take into account the nutritive value (Wilman & Riley 1993) of the alternative pasture species available.

The impact of changes to feed quality on lamb growth rate during lactation and lamb weaning weight were determined in a spreadsheet model developed by Woodward & Webby (unpublished). Resulting ewe weights, lamb weights and weight gains were then reset in Stockpol. Changes to post-weaning lamb growth rates that were owing to changes in feed quality were measured using a second model developed by Woodward & Webby (2000). This information was again used to adjust the liveweight gains in Stockpol.

The biological and financial impacts of altering the forage traits were determined for a conventional lamb supply system, and a contract supply system where a portion of the lamb crop was marketed earlier, or later than during the conventional supply seasons (e.g., in October–November or June–September). For the conventional system, the alignment of forage supply and demand was optimised by adjusting stocking rate, forage conservation and seasonal lamb supply pattern. The livestock systems used were derived to mirror those typically used within the regions involved. The approach taken was as follows:

a. For each region, the conventional system was established on the basis of the best gross margin (GM) achieved through the adjustment of stocking rate, lamb sale times, lamb carcass weights and the harvesting and feeding out of conserved feed.
b. From base system with stocking rate constant, and by modifying the parameters identified for the options in "a", above. Seasonality of feed supply was reduced, or feed quality was increased.
c. The base ewe mating weight, lambing percentage, and lamb weaning weight established for "a" above were adjusted for the seasonality and quality cases.
d. From the base in "a" above, in the contract supply systems, lamb sales were moved to before the start, and after of the main slaughter season, and then the same approach was taken as for "b" and "c" above. Seasonal price premiums for lambs in the contract supply system were defined for each region.

Results

Lamb carcass weights, value per head and farm gross margin for each scenario tested for all regions are summarised in Tables 5, 6 and 7. Changes in stocking rate, ewe-mating weight, lamb weaning weight, lambing percentage and wool produced per hectare are shown in Tables 2, 3 and 4.

Table 5   Mean lamb performance and financial summary for Region 1.

System	Ewe lamb carcass wt (kg)	Ewe lamb value ($/head)	Ram lamb carcass wt (kg)	Ram lamb value ($/head)	Farm gross margin ($/ha)
Conventional					
Base	14.6	41.36	17.4	48.51	797
Seasonality	15.2	42.92	18.2	50.59	923
Quality	17.4	47.78	18.3	50.35	944
Contract					
Base	17.7	64.72	17.7	54.52	739
Seasonality	17.7	64.30	18.3	55.92	849
Quality	17.1	62.55	19.0	57.93	863

Table 6   Mean lamb performance and financial summary for Region 2.

System	Ewe lamb carcass wt (kg)	Ewe lamb value ($/head)	Ram lamb carcass wt (kg)	Ram lamb value ($/head)	Farm gross margin ($/ha)
Conventional					
Base	15.9	48.33	16.3	52.22	549
Seasonality	16.7	50.53	17.2	54.91	626
Quality	17.2	53.72	17.8	57.52	607
Contract					
Base	14.8	47.54	15.7	51.60	536
Seasonality	16.1	51.44	17.5	56.82	609
Quality	15.4	51.39	16.8	55.97	589

Table 7 Mean lamb performance and financial summary for Region 3.

System	Ewe lamb carcass wt (kg)	Ewe lamb value ($/head)	Ram lamb carcass wt (kg)	Ram lamb value ($/head)	Farm gross margin ($/ha)
Conventional					
Base	15.3	$45.67	17.1	$56.08	$587
Seasonality	15.3	$45.67	17.1	$56.08	$629
Quality	16.8	$54.11	17.3	$62.42	$712
Contract					
Base	14.7	$47.40	16.3	$57.69	$611
Seasonality	14.7	$47.35	16.3	$57.19	$637
Quality	15.8	$54.36	17.4	$62.30	$72

Region 1

The improved seasonality of pasture supply allowed ewe body weights to increase through lactation, thereby increasing lamb weaning weights by 2.1 kg. It also allowed mating weight to increase to 70 kg and lambing percentage to improve from 130% to 144%. These production increases were also achieved through improved pasture quality. In comparison gains of $126 and $147/ha above the base were estimated for the conventional improved seasonality and quality scenarios, respectively.

The higher stocking rate in the contract supply system is the result of the extra lambs being carried into the winter. In fact, ewe numbers were reduced from 2540 to 2329 with corresponding reduction in the number of ewe hogget replacements. With fewer ewes being wintered, gross margins were reduced (compared with conventional) by $58, $74 and $81/ha for the base, seasonality and quality contract scenarios, respectively.

Region 2

Improvement in seasonality and quality of pasture allowed ewe mating weight to increase by 5 kg and lambing percentage to increase by 5% for both the conventional and contract farms. Improved lamb carcass weights were worth an extra $77/ha and $58/ha for the improved pasture seasonality and quality, respectively. The base contract system did not perform as well as the base conventional (being $13/ha less), but gains from the improved seasonality and quality were similar at $73 and $53/ha, respectively.

For the contract system, summer–autumn pasture cover was high (2400 kg DM/ha) compared with 2040 kg DM/ha for the conventional system. This affected pasture recovery as a higher rate of decay function in Stockpol is activated when pasture cover exceeds 2200 kg DM/ha (Webby et al. 1995). The result was a lower cover going into the winter and one stock unit/ha less. This was despite the additional hay which was made in both the base contract farm and the quality contract farm (2500 and 3900 bales of hay

respectively). These were sold and the income included in the GM as shown in Table 6.

Region 3

No change in stocking rate was required for any of the Region 3 scenarios reflecting the good match existing between winter pasture growth rates and sheep feed demand. Improved seasonality for both the conventional and contract systems differed only from base in a lower requirement for silage. As a consequence, costs were lower and GMs increased by $42 and $26/ha through improved pasture seasonality for both the conventional and contract systems, respectively. However, for the improved quality scenarios the gains were much more substantial at $125 and $110/ha for both the conventional and contract system, respectively. These gains reflected a heavier ewe weight at weaning, a higher lamb weaning weight, a higher lambing percentage and higher lamb growth rates post weaning. The same amount of silage was made in both systems. In the contract system, where lambs were supplied on average 1 month earlier than the conventional system the GM improved by $24, $8 and $9/ha for the base, seasonality and quality scenarios, respectively.

Discussion

Improving feed quality had the greatest effect on farm GM. For the winter-cool, summer-wet and winter-warm, summer-dry (Regions 1 and 3) cases where the advantages of better forage quality could be expressed most, increases in GM/ha ranged from $110–$148. Where forage quantity was a major constraint in both winter and summer (winter-cold, summer-dry, Region 2), the potential advantages of improved quality were not fully realised. In these cases reducing the degree of seasonality increased the GM/ha by approximately $70.

These GM increases do not include any extra costs associated with improving forage seasonality or quality over-and-above the expenses already incurred in the base systems. Table 8 provides a guideline to the likely

costs of pasture renewal given different methods of establishment, persistence and renewal frequency. All methods, where applicable, include one spray, seed, sowing, cultivation, rolling, harrowing and starter nitrogen, but not capital and maintenance fertiliser applications. Costs include an annual interest charge of 7% on the initial cost. The appropriate costs should be deducted from the GM gains to gauge the net benefit of improved seasonality or quality of forage supply.

Table 8 The annual costs ($/ha sown) for different types and rates of pasture renewal.

Method of seed bed preparation	20 year or 5% /year	10 year or 10% /year	5 year or 20% /year
Cultivation	$71.40	$101.15	$160.65
Direct drilling	$53.28	$ 75.48	$119.88
Oversowing	$43.56	$ 61.71	$ 98.01

To achieve a net financial gain from improving seasonality in pasture supply or pasture quality, such extra costs would need to be less than $70–$120/ha/year. Table 8 indicates that improved pasture would need to persist for at least 5 years, or produce considerably more feeding advantages than the figures used in these analyses. Stevens *et al.* (2000) showed that farm profitability increased substantially in Southland where new pasture performance peaked at 2 to 4 years; and the advantages over the original sward lasted for 10 to 14 years. Studies by Webby *et al.* 1990 and Barker *et al.* 1999 showed that new pasture species could be established to advantage in hill country. However, changes in seasonality of feed supply and feed quality do not necessarily have to occur through pasture improvement. Improved grazing management (Sheath *et al.* 1984), soil fertility (Gillingham *et al.* 1990) and subdivision (Fitzharris & Wright 1984) can all contribute to less seasonality in pasture supply and improve feed quality. Financial analysis suggests that management and soil fertility must also be addressed in pasture improvement (Parminter 1991). One would assume that in any fine-tuned farm system these factors would not be an issue, leaving the opportunity for substantial gains to be made through pasture or forage supply improvement. Such improvements may include new pasture species, forage cropping, conservation and strategic supplementation with grain (Boom & Sheath 1998, 1999; Drew & Fennessy 1980).

Conclusion

Other than when large seasonality constraints exist, improving pasture quality will increase sheep farm performance and profitability significantly. New pasture cultivars that are developed will require agronomic traits that allow them to persist and retain their benefits for at least 5 to 7 years.

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