High sheep performance on hill country: Critical winter management decisions

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Abstract

The winter has long been recognised as an important period for sheep management on hill country. Despite this, little is known about how farmers manage over this period. A single-case study design was used to undertake a qualitative analysis of the management practices of a high performing hill country farmer. The importance of non-negotiable targets at the start and end of winter for average pasture cover and sheep live weight and condition score was central to the farmer's consistent high performance. Feed planning was important for ensuring the development of a feasible winter plan and specifying key targets that had to be met at the start of the winter. A critical feature of plan implementation is area allocation and the use of post-grazing residuals to achieve planned animal performance levels. Because hill country farmers face considerable uncertainty in the environment, monitoring, micro-budgeting, and the selection of appropriate contingency plans were critical for ensuring key targets were consistently achieved. Another critical element of the farmer's management was the minimisation about the mean of the distribution of live weight or condition score of different sheep classes through preferential feeding of younger and/or lighter stock and also the minimisation of the distribution of pasture cover on grazing blocks at set stocking for lambing. The results from this study provide guidelines about the critical decisions hill country farmers need to make over winter in order to achieve high levels of sheep performance.

Additional keywords: tactical, feed management, farmer knowledge, decision making, grazing management.

Introduction

The last twenty years have seen a dramatic increase in sheep productivity (Cocks and Brown, 2005) as sheep performance has become an increasingly important focus of hill country management. Despite this, little is formally known about how farmers plan, implement and control their hill country sheep systems. The industry has also recognised that some farmers are better managers than others when it comes to achieving consistent high sheep performance. If the management practices of these better farmers could be captured and passed onto other farmers, there is the potential for further large gains in productivity in the sheep industry. The winter has long been recognised by farmers as an important period for sheep management on hill country (Geenty, 1997), but limited research has been undertaken into the winter management practices of farmers. Decisions made over this period can impact critically on pasture quality, pasture cover at lambing, lambing percentage, ewe and lamb weaning weights and replacement frame size and lifetime performance (Geenty, 1997). This paper will report on a qualitatively analysed case study of a farmer's winter management practices that are critical for achieving consistent high sheep performance.

Method

A single-case study design (Yin, 1993) was used to investigate the decision making processes used by a hill country farmer who achieved levels of physical and financial performance that were consistently in the top 10% for his land class. Farm management consultants and local farmers were used to select this “expert” farmer. Semi-structured interviews and field observations (Gray, 2001) were used to collect data on the case farmer’s decisions over two years. Interviews were transcribed verbatim to minimise bias (Denzin, 1989) and then the transcripts were analysed in-depth using qualitative data analysis (Dey, 1993; Miles and Huberman, 1994). Management practices critical to achieving high performance were derived from the data, verified with the farmer and then compared with the literature.

Results and Discussion

The case farmer operates a 657 ha semi-finishing, summer wet (average annual rainfall of 1500 mm), hill country property south-east of Pahiatua. The farm comprises 30 ha of flats, 50 ha of rolling but cultivatable land, 120 ha of uncultivable easy hills and 457 ha of steep hill country. The farm has Olsen P levels between 15-25 with soil pH between 5.4 – 5.9. Estimates suggest the farm grows around 9500 kg DM/ha/yr and stock consume 8000 kg DM/ha/yr. In 2002/03 the property wintered 3775 ewes, 1215 ewe hoggets, 203 R1yr bulls and 365 R2yr bulls at an overall stocking rate of 11.8 su/ha. Sheep comprise 61% of the total stock units run on the property. The farm has achieved lambing percentages of 140, 132, 153, 146 and 139% over the last five years. Physical and financial performance for the year prior to the study is summarised in Table 1.

Table 1. A comparison of the case farmer’s physical and financial performance to district data[1] for the 2001/02 year.

Performance measure	Case farm		District average		Top 10%	
	per ha	per su	per ha	per su	per ha	per su
Net production (kg CW)	304	27.4	243	23.6	290	24.0
Wool production[2]	56	5.1	55	5.4	67	5.5
Stock units	11.1	-	10.3	-	12.1	-
Revenue/sheep su	-	$86.06	-	$81.78	-	$89.15
Revenue/cattle su	-	$116.25	-	$73.60	-	$117.46
Gross farm revenue	$1,094	$98.97	$833	$80.68	$1,159	$96.13
Standard expenses	$354	$32.03	$445	$43.12	$449	$37.24
Economic farm surplus	$698	$63.18	$345	$33.45	$636	$52.76
Lambing %	153.4%		128.6%		133.0%	
Return on capital	14.6%		7.9%		9.9%	

[1] Data obtained from Baker & Associate’s Farm Analysis Bureau.
[2] Wool/ssu multiplied by stocking rate.

The success of the farmer's winter management can be attributed to two factors. First, he has identified key winter targets that are critical for the achievement of high sheep performance on hill country and the means of achieving these targets. Second, the farmer has developed a sophisticated tactical management process that allows him to consistently achieve these targets, despite variations in pasture growth rates, pasture quality and livestock markets over this period.

Key Winter Targets

The farmer defines winter as the period from May 1^{st} until the ewes are set stocked (8^{th} September), some ten days before the planned start of lambing. A primary goal for this period is to ensure that there is sufficient feed on-hand at set stocking to guarantee that, for the farmer's stocking rate, lambing date (18^{th} September) and sheep performance levels (bearing rank), average pasture cover on the sheep block does not fall below 1100 kg DM/ha at balance date (30th September). At this level of pasture cover, ewes and lambs are well fed during early lactation. For example, his triplet-, twin- and single-bearing ewes are set-stocked onto 1300 kg DM/ha, 1100 -1200 kg DM/ha and 1000 kg DM/ha, respectively (Table 2).

Table 2. Pasture cover levels and stocking rate for different stock classes over spring.

Stock class	Pasture Cover at Set-stocking (kg DM/ha)	Stocking rate (head/ha)
Triplet-bearing ewes	1300	2.2
Triplet-bearing ewes	1300	6.5
Twin-bearing ewes	1100 - 1200	9.5
Single-bearing ewes	1000	11.0
Late ewes – single-bearing	1000	11.5
Late ewes – twin-bearing	1000	10.0
In-lamb hoggets	1200	11.5
Dry hoggets	1000	15.5
R1yr cattle	14 - 1500	2.8
R2yr cattle	1400 - 1500	2.2

[1] These ewes are on the cattle block until docking, after which they join the triplet bearing ewes on the sheep block which is then stocked at 9.0 ewes/ha.

[2] These ewes are on the sheep block.

A modelling study by Bircham (1983) showed that maintaining pasture cover above 1000 kg DM/ha was critical for ensuring that pasture growth, pasture intake and live weight gain of ewes and lambs were not restricted over spring. Average pasture cover must be reduced to 1100 kg DM/ha at balance date to ensure pasture cover is maintained at around

1200 kg DM/ha (4 cm) over the late spring in order to maintain pasture quality (Gray *et al*., 2004). Recent research by Morris and Kenyon (2004) found that to maximise ewe and lamb weaning weight and lamb survival for twin- and triplet-bearing ewes, sward height over lactation did not need to exceed 4 cm (1100 – 1200 kg DM/ha).

The farmer does not just aim for a specific average pasture cover on his various blocks at set stocking for lambing. He also stresses the importance of achieving the correct distribution of feed within each block. Failure to achieve this will result in the deterioration in pasture quality on paddocks with too much feed, whilst stock on paddocks with insufficient feed will be underfed. This could result in additional lamb losses and lighter ewes, hoggets and lambs at weaning.

The farmer uses a feed planning process to determine the required average pasture cover on-hand at May 1st to ensure he achieves his average pasture cover target at set stocking for lambing. The farmer typically aims to have 1400 kg DM/ha, 2000 kg DM/ha and 1500 kg DM/ha on his sheep, R1yr and R2yr bull blocks respectively by May 1st. To ensure these targets are met, stock sales are planned to dramatically reduce feed demand over summer. For example in 2003, feed demand was reduced from 40 kg DM/ha/day just prior to weaning to 20 kg DM/ha/day in late March through the sale of 4620 lambs, 700 cull ewes, 360 R3yr bulls and 200 R2yr bulls. If conditions over the summer-autumn are drier than normal, then stock are sold earlier to ensure May 1st pasture cover targets are met.

The farmer's other important goals are to ensure that the ewes are in good condition (≥ 2.5 C.S.) at set-stocking for lambing and the ewe hoggets reach a target live weight of 45 kg at hogget shearing (15th September) with a minimum live weight of 38 kg. To achieve these targets, he aims to have his ewes at a condition score of 3 and his hoggets at a live weight of 41 kg at May 1st. Summer-autumn stock sales are manipulated to ensure the ewes and hoggets have sufficient feed to meet the May 1st targets. At a condition score 3, the farmer expects his mixed age ewes and two tooths to weigh 62 kg and 58 kg LW respectively. The farmer also seeks to minimise the distribution of live weight and condition score about the mean for the ewe flock, by preferentially feeding the younger and thinner ewes in early to mid pregnancy and the multiple bearing ewes in late pregnancy. Similarly, Kenyon *et al*. (2004a) advocated that farmers should manage their ewe flocks to achieve minimum, rather than average, condition score or live weight targets to optimise performance from a limited feed resource.

Post-grazing residuals are used by the farmer to ensure the ewes are fed to requirements and condition score loss is minimised over winter. Post-grazing residuals are gradually reduced from 1200 kg DM/ha at tupping to 1000 kg DM/ha in early pregnancy to maintain condition and minimise the risk of embryonic loss, a practice recommended by Geenty (1997). Residuals are further reduced to 800 kg DM/ha in mid-pregnancy once the risk of embryonic loss is low. Loss of ewe body condition is also minimised because the farmer winters a high proportion of rising two year old cattle (23% of total stock units). These cattle, rather than the ewes, clean up the poorest quality feed on the farm. A practice that Smeaton *et al*. (1984) advocated to clean up rank pasture in order to minimise ewe body weight loss.

After mid-winter shearing in late July, the post-grazing residuals are increased to 1000 kg DM/ha to increase ewe intakes and maintain ewe condition post-shearing. To ensure adequate feed is on-hand to achieve the increased residuals, an area around the woolshed is shut up in early May. A mid-winter shearing policy has been adopted to increase lamb birth weights in the multiple-bearing ewes and therefore improve lamb survivability (Kenyon *et al.,* 2004a). Lamb survivability is also improved through the administration of a mid-winter iodine drench to the ewes.

Ewe feeding in late pregnancy aims to minimise ewe condition score loss, ensure good udder development and achieve optimum lamb birth weights, growth and survival (Geenty, 1997). To this end, the farmer feeds the ewes on the basis of bearing rank. The triplet-bearing ewes are set-stocked onto 1300 kg DM/ha at 6.5 ewes/ha, four weeks before lambing. At the same time, the twin- and single-bearing ewes graze pastures down to 1000 kg DM/ha and 900 kg DM/ha respectively for a further two weeks. They are then set stocked onto 1200 kg DM/ha and 1000 kg DM/ha at 9.5 ewes/ha and 11.0 ewes/ha respectively, 10 – 14 days prior to lambing.

The results of Morris and Kenyon (2004) indicated that twin- and triple-bearing ewe and lamb performance were maximised when pasture covers did not fall below 1200 kgDM/ha (or a sward surface height of 4 cm). In addition, Morris and Kenyon (2004) reported that herbage intakes of twin- and triplet-bearing ewes did not differ in late-pregnancy and lactation. This suggests that under conditions in which herbage is not limiting, twin- and triplet-bearing ewes do not need to be managed separately. However, when covers are below 1200 kg DM/ha, triplet-bearing ewes would benefit most from higher feed allowances. Similarly, Everett-Hincks *et al*. (2005) reported that at lower sward heights (< 4 cm), triplet lambs were less likely to stand, find the dam's udder and follow the dam within 5 minutes of tagging than twin or single lambs.

At least a month prior to mating (6th May), the hoggets are separated into light and heavy hoggets and graze pastures down to 1100 kg DM//ha and 1000 kg DM/ha respectively. The farmer aims to have his hoggets at an average live weight of 41 kg with a minimum live weight of 38 kg by May 1st. This is important because Kenyon *et al.* (2004b) suggest that for every 1 kg live weight above 36 kg at mating, hogget lambing percentage increased 2%. An earlier study found that for each extra 1 kg live weight at hogget mating there was a 3.3% increase in hoggets mated over hoggets joined and a 3.5% increase in lambs born per hogget joined (McMillan and Moore, 1983). The hoggets are mated for two cycles and the two mobs are then combined and graze pastures down to 900 kg DM/ha until set stocking (8th September) when the dry hoggets are set stocked at 15.5 hoggets/ha onto 1000 kg DM/ha and the in-lamb hoggets are set stocked at 11.5 hoggets/ha onto 1200 kg DM/ha three weeks prior to lambing.

The final goal the farmer has for the winter is to ensure pastures are of high quality and in an actively growing state by set stocking. The actions the farmer takes to achieve this can be classified as either remedial or preventative. Remedial activities involve the cleaning up of rough feed that has previously declined in quality with low priority stock classes. To achieve this, the farmer runs 365 R2yr bulls on the farm over winter. The cattle are grazed with, or behind the ewe mobs depending upon the state of the paddock and the worst paddocks are targeted first. The ewes are used to clean up poorer quality pastures over winter and are of most use when they can graze down to 800 kg DM/ha during mid-pregnancy. The importance of cattle in the management of pasture quality on hill country (Suckling, 1975; McCall, 1994; Lambert *et al*., 2000) and the less selective grazing behaviour of older cattle is well known (Cazacarra and Petit, 1995).

Preventative actions are designed to avert a further decline in pasture quality over the winter. To ensure this, the farmer grazes his longest paddocks first in the rotation and lightly grazes paddocks over 3000 kg DM/ha with high priority stock (R1yr bulls and in-lamb hoggets) to prevent them becoming rank.

Tactical Management

To achieve his critical winter targets, the farmer uses a tactical management process that comprises the three functions – planning, implementation and control. As such, the farmer first develops a feed plan for the winter period that is designed to achieve the critical targets set out in the previous section. This plan is then implemented. However, because of the inherent uncertainty faced by hill country systems from variations in pasture growth rates, pasture quality and livestock markets over this period, the farmer uses control processes to minimise the impact of deviations from the plan caused by such uncertainty. A recent survey by Nuthall (2006) reported that farmers and consultants ranked planning, implementation and control as the most important skill competencies required by New Zealand farmers.

Planning

The farmer uses an iterative feed planning process to develop the feed plan (Figure 1). The process begins in January when the farmer determines which areas will be allocated to sheep and cattle for the spring. The cattle are allocated the easier contour country and the sheep the steeper country. The farmer decides, on the basis of the performance of these blocks over the last 12 months, whether they are growing more grass than in the past. If he thinks the blocks are producing more pasture, he will adjust the spring stocking rate accordingly for each stock class. For example, in year one of the study, the farmer believed his cattle country was growing more pasture than in the past and as a result, he decided to increase his cattle stocking rate by 0.8 – 1.0 csu/ha. If the farmer does not believe the blocks are producing more pasture than normal, he will use the same spring stocking rate as in the previous year (see Table 2).

Once the block area and stocking rates are determined, the farmer calculates, given his desired ratio of older to younger cattle, how many cattle he can winter (Figure 1). He then estimates the likely lambing percentages for the ewes and ewe hoggets based on their current live weight relative to historical data and expected feed conditions through autumn. This information is then used to estimate the proportion of triplet-, twin- and single-bearing ewes, and dry and lambing hoggets that would be on-hand at set stocking. From this, given his stocking rate assumptions (Table 2) and the allocated sheep area, the farmer works out how many sheep he can winter. The feasibility of this initial plan is then tested by estimating the feed demand of each stock class from set stocking to lambing and then from lambing to balance date to determine if the expected pasture growth rates will be sufficient to match feed demand and meet the pasture cover targets for balance date (Figure 1). If the plan does not appear feasible, adjustments will be made to stock numbers.

In the next step in the process (Figure 1), the farmer completes a formal feed budget (using an Excel spreadsheet developed by a local consultant) for the period late March to balance date to further test the feasibility of the plan and estimate the level of average pasture cover required at May 1st to make the plan work. If the plan is not feasible because there is insufficient feed on-hand, alternative plans using additional nitrogen or delaying the purchase of cattle in late winter and early spring are investigated. If the plan suggests surplus feed is available, the farmer will investigate options such as retaining R3yr cattle for longer and/or reducing autumn nitrogen inputs. At May 1st, when the farmer has a clearer idea of the feed and market situations, the feed budget is revised (Figure 1).

Although other studies (Nuthall 1992, 1996; Parker *et al.,* 1993; Nuthall & Bishop-Hurley, 1999) have reported that between 20-40% of pastoral farmers use formal feed planning methods, these studies provide little information about the actual planning process. In contrast, a study by Gray *et al*., (2003) did described how high performing dairy and sheep and beef farmers planned over summer. However, the processes used by the farmers in this study were informal and did not employ formal feed budgeting.

Implementation

A feed budget is used to develop a technically feasible plan for the winter. However, the correct implementation of this plan is equally important. Because the farmer grazes the majority of his stock classes (ewes, hoggets, R1yr bulls) on separate blocks over winter, the allocation of stock classes to blocks is a critical element of plan implementation. This process ensures stock are fed to requirements and target pasture cover levels at set stocking for each block are met. The area allocated to each stock class is a function of the final pasture cover the farmer wants on the block at set stocking, the initial pasture cover on that area at May 1st and the match between feed supply (pasture growth plus supplements) and feed demand from May 1st to set stocking. For example, the 203 R1yr cattle require 881 kg DM/head for the period May 1st to set stocking. The initial average pasture cover on their block is 2000 kg DM/ha at May 1st and the farmer wants an average pasture cover of 1500 kg DM/ha at set stocking. Pasture grown over this period equates to 1702 kg DM/ha plus another 300 kg DM/ha is supplied from autumn applied nitrogen (30 kg N/ha). Because the average pasture cover on the block can fall by 500 kg DM/ha, the total available feed on the block over winter is 2502 kg DM/ha. Given each bull requires 881 kg DM/ha, the block needs to be 71.5 ha (2.8 bulls/ha).

The effective implementation of a feed plan requires that stock are fed to the level specified in the plan. The implementation of a grazing rotation and the use of post-grazing residuals are critical for ensuring the feed plan is implemented correctly. Nuthall (2006) reported that effective plan implementation was an important skill required by farmers. This farmer has clearly specified post-grazing residuals for different stock classes for different times of the winter which are designed to feed stock to requirements.

Control

The inherent uncertainty faced by managers of hill country systems means effective planning and implementation are not sufficient to ensure good performance. Uncertainty is primarily associated with climate variation (influencing feed supply), but also pests (e.g. porina), diseases (e.g. internal parasites) and market price fluctuations. The farmer copes with uncertainty through his control system. By monitoring and the use of micro-budgeting (Gray *et al*., 2003), the farmer identifies if there is a deviation from the plan. If a deviation is identified, the farmer uses decision rules to choose the most suitable contingency to minimise the impact of the deviation. The plan is then modified, implemented and its progress monitored (Figure 2).

To identify if the there is a deviation from the plan, the farmer monitors a combination of pasture (average and distribution of pasture, pasture quality, pasture growth, pre- and post-grazing residuals), soil (wetness, pugging damage), animal (liveweight or conditions score (average and distribution), liveweight gain, scanning percentage) and market ($NZ, works and store prices) factors. The farmer also uses a form of micro-budgeting (Gray *et al*., 2003) to identify potential feed deficits or surpluses. He has a target for the number of grazing days that he can expect from a specified number of paddocks (usually 4 – 5) for a specific mob at different times of the winter. If he forecasts that the number of grazing days from the paddocks he is due to graze in the next fortnight is significantly less than this, this will identify a potential feed deficit.

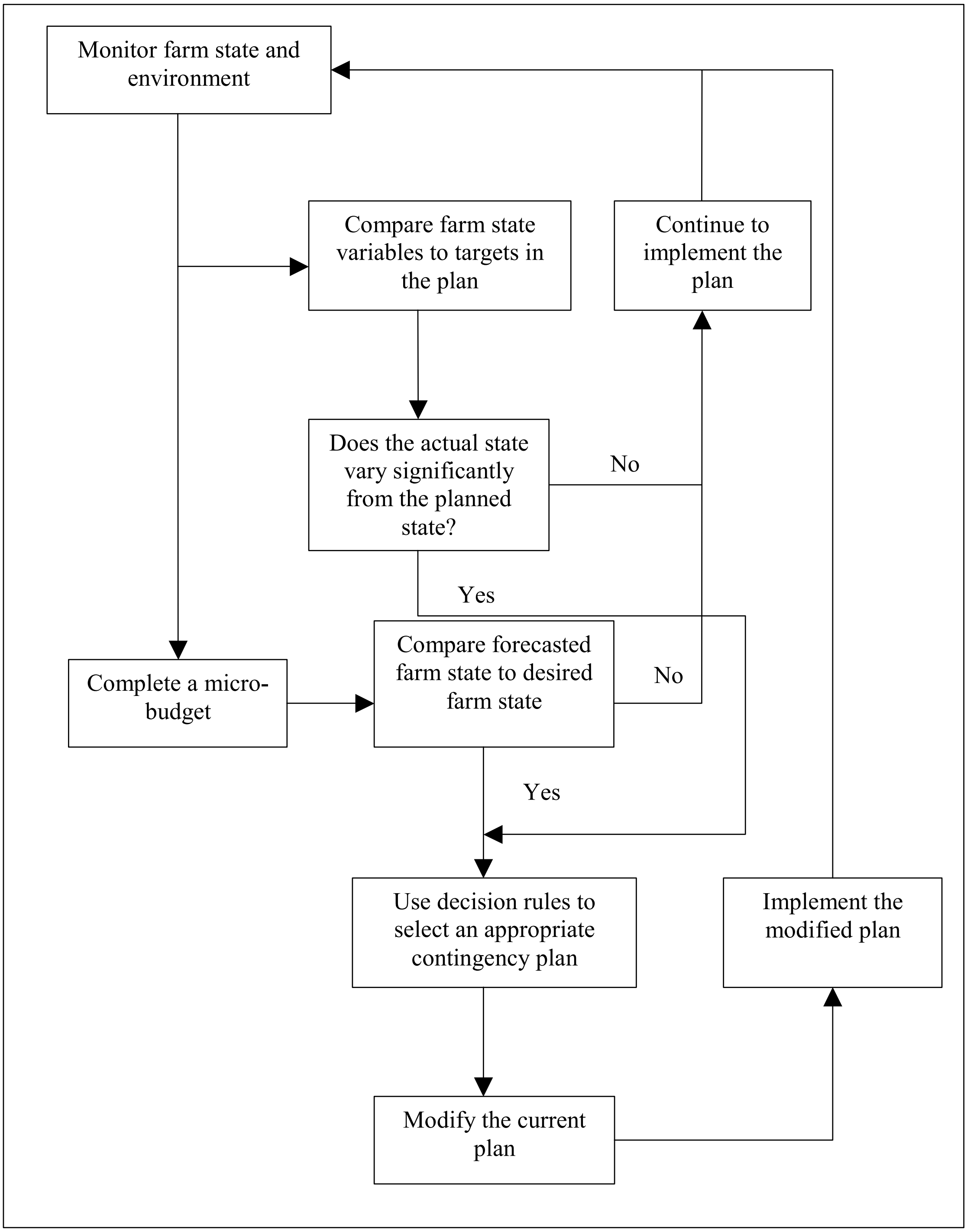

Figure 2. The control process used by the farmer.

Table 3. Contingency plans for dealing with winter feed problems.

Feed	Deficit	Feed	Surplus
Reduce Feed Demand	**Increase Feed Supply**	**Increase Feed Demand**	**Reduce Feed Supply**
1. Reduce intake of R2yr bulls 2. Place R2yr bulls in the pine plantation 3. Reduce dry hogget intake 4. Sell 100 “surplus” dry hoggets 5. Reduce single-bearing ewe intakes late winter 6. Reduce intake of tail end R1yr bulls 7. Sell R2yr cattle	1. Feed balage reserve 2. Feed forage crop earlier 3. Apply urea early 4. Apply additional urea	1. Increase ewe intakes 2. Increase hogget intakes 3. Increase R1yr bull intakes 4. Increase thin R2yr cattle intakes 5. Buy cattle in earlier 6. Buy in additional cattle	1. Reduce urea application

Table 4. Changes in the farmer’s priority ranking over winter.

Priority ranking	**Early winter**	**Mid winter**	**Late winter**
1	Pasture cover	Pasture cover	Pasture cover
2	R1yr bulls Light ewe hoggets	R1yr bulls Light ewe hoggets	Triplet-bearing ewes
3	Two tooths Thin ewes	Two tooths Thin ewes	Twin-bearing ewes
4	Heavy ewe hoggets	Heavy ewe hoggets Thin R2yr bulls	Single-bearing ewes In-lamb hoggets R1yr bulls
5	Fat MA ewes	Pasture quality	Thin R2yr bulls
6	Pasture quality	Fat MA ewes	Late twin-bearing ewes Dry Hoggets
7	R2yr cattle	Fat R2yr bulls	Late single-bearing ewes Pasture quality
8			Fat R2yr bulls

Micro-budgeting is also used by the farmer to ensure that he has the correct distribution of feed both within and across his various blocks come set stocking. Every 2 – 4 weeks and then more frequently as set-stocking approaches, the farmer estimates the likely distribution of feed at set-stocking, given current pasture cover levels, his grazing rotations and expected pasture growth rates. This is then compared to the planned distribution and stock rotations are manipulated to ensure that the desired feed distribution is achieved.

The information collected through monitoring and micro-budgeting is used to identify deviations from the initial plan. Once identified, the farmer has a set of contingency plans (Table 3) from which he chooses the best option for the problem he is faced with. Decision rules, similar to those reported by Gray (2001), are used to determine the best contingency to implement. Three factors are taken into account when making the decision: (1) time of year, (2) the farmer's priorities and (3) the state of the farm. Time of year is important because it determines both what options are available to the farmer and his priority ranking. The farmer's priority ranking changes throughout the winter (Table 4) and is based on the impact of the factor on farm performance. Finally, the state of the farm relative to the desired state further influences the farmer's choice of contingency plans. The priority ranking of a factor depends upon its state relative to the farmer's desired state. For example, if the ewe flock is 5.0 kg live weight ahead of target, it will have a lower priority ranking than if it was 5.0 kg live weight below target.

Summary and conclusions

The importance of non-negotiable targets at the start and end of winter for average pasture cover and sheep live weight and condition score was central to the farmer's consistent high performance. Feed planning was important for ensuring the development of a feasible winter plan and specifying key targets that had to be met at the start of the winter. A critical feature of plan implementation is area allocation and the use of post-grazing residuals to achieve planned animal performance levels. Because hill country farmers face considerable uncertainty in the environment, monitoring, micro-budgeting, and the selection of appropriate contingency plans were critical for ensuring key targets were consistently achieved.

Minimisation of the distribution of live weight or condition score about the mean of different sheep classes through preferential feeding of younger and/or lighter stock was also found to be a critical element of the farmer's management as was the minimisation of the distribution of pasture cover about the mean of blocks at set stocking for lambing.

The results from this study provide guidelines about the critical decisions hill country farmers need to make over winter in order to achieve high levels of sheep performance. The paper identifies key targets that will assist farmers with planning and control decisions and provides practical methods for achieving important objectives such as minimising the distribution of condition score within various sheep stock classes and ensuring the correct distribution of pasture cover at set-stocking.

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