

Case studies of alternative wintering practices in sheep, beef and deer farming in Southern New Zealand

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Abstract

Practical uptake of alternative winter-feeding practices can be aided by providing examples of the processes farmer have used, and their experiences when implementing non-traditional approaches. Six farmers in Otago and Southland used a range of forage options over a 3-year period. Crop yield and crop nutrient concentration data were collected by the research team in winter and spring. Information on management practices, grazing days, and in some cases animal performance was recorded by the farmer. Winter yields were quite varied, ranging from approximately 6 to 10 t DM ha⁻¹. After grazing during winter, forage regrowth contributed between 1,900 and 3,800 kg DM ha⁻¹ to spring feed requirements. Benefits came both from the management methods and the actual wintering practices. Reducing mud was identified as a key aspect of all practices. Wintering of heavy cattle still compromised soil strength in very wet soil conditions. The replacement of traditional winter crops with alternative wintering options increased complexity and the need for precision, while offering some opportunities in autumn and spring, such as increasing spring feed supply in sheep, beef and deer systems.

Keywords: animal welfare, environmental impact, functional forage mixtures, mud

Background

In seasonal production systems winter feed supply is a key component to maintain stocking rate of breeding livestock to ensure that animal feed demand increases rapidly to capture the spring feed flush in a profitable lactation (Stevens et al. 2011). Winter feeding is also important to meet gestation requirements enabling the production of healthy offspring with maximum lifetime performance potential (Kenyon et al. 2011).

Grazing winter crops in situ is a common practice in southern New Zealand for 60 to 100 days. It often occurs

in wet conditions, causing significant soil disruption (Monaghan et al. 2017), resulting in animals being exposed to muddy conditions. This generates potential welfare concerns and negative public perception, for both animal comfort and animal nutrition (MPI 2020). The nutrition of the animal can be compromised due to poor utilisation of the available feed and potential under-allocation that results (Thompson and Stevens 2012). In addition to animal welfare concerns, the development of mud can lead to soil loss and sediment and microbial loading in adjacent waterways (Monaghan et al. 2017). Alternative wintering on all-grass may also result in similar muddy condition (Stevens et al. 2011), but often these effects are transitory due to the more frequent transfer of animals to fresh pasture. New approaches such as 4-day shifting in winter have also been demonstrated to reduce pasture damage when mob grazing (Stevens et al. 2011).

Farmers have begun investigating a range of options to meet these challenges (Stevens et al. 2021), in particular meeting animal feed demand and animal welfare requirements while minimising soil loss and water contamination. Options to reduce winter grazing of single use crops include all-grass wintering, multi-graze crops and bale grazing (Simon et al. 2024). The progress of farmers undertaking these investigations can provide a resource for other farmers who are yet to move away from single-graze winter forage crops. Farmers are being assisted by a range of Agribusiness experts. These trend-bucking farmers are generating insights into these new options. This paper documents outcomes from farms which have used a range of alternative winter-feeding options in southern New Zealand over the past 3 years.

Approach

Six farmers in Otago and Southland volunteered to participate in a programme of recording their wintering practices to develop case studies which could inform

Table 1 Farm characteristics and soil descriptors for the farms involved in the study (information sourced from S-Map Online, <https://smap.landcareresearch.co.nz/maps-and-tools/app/>) and soil chemical properties from soil testing of the paddocks chosen.

Case study	1	2	3	4	5	6
Farm size (effective ha)	840	235	1050	890	4330	4330
Study year	2023	2023	2023	2023	2022	2023
Region	South Otago	Western South-land	Central South-land	Central South-land	Te Anau basin	Te Anau basin
Animal type	Sheep	Beef	Sheep	Sheep	Deer	Beef
Liveweight (kg) ¹	70	350	68	65	85	435
Winter feed allowance (kg DM/d) ²	1.63	6.1	1.61	1.59	2.3	9.47
Soil classification	Mottled Fragic Pallic	Acidic Firm Brown	Argillic-fragic Perch-gley Pallic	Acidic-pedal Allophanic Brown	Cemented Firm Brown	Firm Allophanic Brown
Bulk density (g/cm ³)	1.22	1.08	1.22	1.08	1	1.09
Texture	Silt	Clay	Silt over clay	Clay	Silt	Silt
N leaching vulnerability	Medium	Medium	Medium	Medium	Very High	Medium
pH	6.0	5.9	6.3	5.9	5.8	5.8
Olsen P	25.3	19.8	8.4	35.1		17.0
Potassium	13.4	5.3	7.4	8.0		5.5
Calcium	11.4	9.7	13.0	14.7		5.0
Magnesium	23.3	17.0	23.9	28.1		8.0
Organic matter	8.2	7.8	11.4	8.6	14.7	12.6
Total N	0.37	0.43	0.53	0.43	0.64	0.47
Total C	4.8	4.5	6.6	5	8.5	7.3

¹ Liveweight excluding pregnancy. Conceptus weight may increase ewe liveweight by 8 to 10 kg by late July when observations were made

² Feed requirements in late July

others to help improve environmental and animal welfare outcomes. The programme's focus was on the integration of multi-species, multi-graze cropping options. One farm also used hay bale grazing for cattle, using a similar approach to that outlined by Simon et al. (2024). Livestock included sheep, cattle and deer. Farmers used feed budgeting to allocate feed to different livestock classes, based on targeted performance requirements. This included maintenance feeding for mixed age ewes, liveweight gain targets of 100 g.d⁻¹ for weaner deer, and 0.3-0.5 kg.d⁻¹ liveweight gain for rising-3-year-old pregnant heifers.

Case study characteristics

Six case studies were chosen from the programme to represent the range and impact of the wintering methods chosen. Descriptions of the farms, practice used, plant species used, livestock class and the soil types are provided in Table 1. Experiences of the farmers were documented to record the practices that they employed,

their observations, and recorded data.

Baseline situation

Prior to changing winter forage practices, farmers were using single-graze winter forage crops such as swedes (*Brassica napus*), kale (*Brassica oleracea*), turnips (*Brassica rapa ssp rapifera*) and fodder beet (*Beta vulgaris*). Winter yields were moderate in the range of 8 to 12 t DM/ha, except for fodder beet which yielded near the South Island average of 19 t DM/ha (Judson et al. 2016). Areas sown in crop were sprayed with glyphosate at recommended rates in mid-November and sown in late November/early December each year, minimising time out of pasture. All components of mixed forage sowings were mixed together for sowing.

Measurements

Crop yield and crop nutrient concentration data were collected by the research team on a single occasion during July as a general indicator of the types of yield

and feed quality that may be expected by farmers. Sampling occurred in the next available area allocated for grazing at the time of collection, and the area grazed within the past 10 days, to provide indicators of yield on-offer and residual yield after grazing. Samples collected for yield were oven dried at 60°C and sent for nutrient analysis using commercial laboratory practices (Hill Laboratories).

The recovery plant growth was measured in 2022 on three farms between 1 August and 25 October. Exclusion cages (eight per farm) were deployed for yield measurements, and additional recovery information

was estimated from grazing records from September to November in 2023 on two farms. Samples for feed quality were also collected and analysed.

This study did not attempt to provide an in-depth analysis of crop agronomic practices but rather sought to detail on-farm processes and outcomes from the application of alternative wintering practices. Information on management practices, grazing days, and in some cases animal performance was recorded by the farmer. A discussion-group approach was used to explore motivations, expectations, practices, and outcomes over a three-year period from 2021-2024.

Table 2 Case study conditions and long-term average rainfall and temperature data compared with the year of study

		Case study	1	2	3	4	5	6
	Winter feed type	Mixed forage ¹	Mixed forage ²	Mixed forage ³	Mixed forage ⁴	Swedes/ Mixed forage ⁵	Bale grazing	
	Livestock	Sheep	Cattle	Sheep	Sheep	Deer	Cattle	
Rain (mm)	Annual	Average (2001-2023)	751	1024	1067	1000	1191	1191
		Study year	661	1131	1130	1068	1026	1262
	Pre-winter	Average (2001-2023)	209	282	271	257	313	313
		Study year	219	390	340	332	319	395
Temperature (°C)	Annual Maximum	Average (2001-2023)	14.8	15	13.5	14.9	13.9	13.9
		Study year	15.5	15.3	13.6	15.1	14.2	13.9
	Annual Minimum	Average (2001-2023)	4.6	5.7	3.6	4.8	4.0	4.0
		Study year	5.1	5.7	3.7	4.9	4.0	4.1
Forage yield	kg DM/ha	7134	3397/5000 ⁶	9749	6136	9450/5938 ⁷	10549	
Proportion mixed pasture	(%)	26	8	18	33	0/32	20	
Forage residual	kg DM/ha	1696	nd ⁸	1985	1400	nd/1597	840	
Grazing days ⁹		3336	1212	4822	2905	4023/1736	1008	
Stocking density ¹⁰	LW/m ²	23.3	42.4	32.9	20.3	34.1/14.8	45.4	

¹ Kale, Turnip, Swedes, Italian ryegrass (*Lolium multiflorum*), Plantain (*Plantago lanceolata*), Phacelia (*Phacelia tanacetifolia*)

² Kale, Turnip, Italian ryegrass, Oats (*Avena sativa*), Phacelia, Balansa clover (*Trifolium balansaiae*), peas (*Pisum sativum*), Faba beans (*Vicia faba*). This mix also included Quinoa (*Chenopodium quinoa*), Crimson clover (*Trifolium incarnatum*), Lentils (*Lens culinaris*), Buckwheat (*Fagopyrum esculentum*), Lupins (*Lupinus albus*), Common vetch (*Vicia sativa*), Sunflower (*Helianthus annuus*) and Millet (*Pennisetum glaucum*). These components did not contribute significantly to winter yield.

³ Kale, Italian ryegrass, Plantain, Faba beans, Peas, Phacelia, Crimson clover, Persian clover (*Trifolium resupinatum*). This mix also included Common vetch, Buckwheat, and Sunflower. These components did not contribute significantly to winter yield.

⁴ Raphanobrassica (*Raphanus x Brassica*), Swede, Leafy Turnip (*Brassica rapa*), Italian ryegrass, Ryecorn (*Secale cereale*), Plantain

⁵ Turnip, Italian ryegrass.

⁶ Crop/baleage

⁷ Swedes/Turnip and Italian ryegrass

⁸ No data collected

⁹ Grazing days = (Forage yield – Forage residual)/Winter feed allowance(from Table 1)

¹⁰ Stocking density recorded as liveweight (LW, from Table 1) per square metre

Data presentation

The information presented here provides a summary of results of crop yields and nutrient concentrations measured and reports the farmers' self-collected data and observations. We use a case study approach to highlight the range of uses and experiences which occurred at the individual farm level, as well as providing some collective experiences. Observations by farmers are discussed in the context of science from the literature where possible. The information provided herein provides an insight into the types of issues and variability that are regularly encountered by farmers in their attempts to quantify and incorporate new technologies and techniques, rather than providing conclusive scientific evidence of the application of these practices. Such scientific evidence would need much greater precision and additional structured experimental design.

Results and Discussion

Conditions during the study

The annual conditions during the study year varied a little from the average (Table 2). However, the pre-winter rainfall was 20% higher than average, ranging from 2 to 38%. This implied that most farms were entering the winter period with soils at or above field capacity.

There were a range of forage options used by the farmers over the monitoring period (Table 2). The winter yields of these forages varied (Table 2), ranging from approximately 6 to 10 t DM ha⁻¹. Autumn-saved pasture yields will range from 2 to 3.5 t DM ha⁻¹ while traditional brassica crops range from 8 to 15 t DM ha⁻¹. These mixtures also had components (predominantly grasses) which will regrow during the spring, providing further grazing and ground cover at that time. These components ranged from 0 in the traditional swede crop (Case study 5) and from 8 to 33% in the mixed forage sowings. Grazing of the multi-species mixtures resulted in a residual herbage mass of between 840 and 1985 kg DM ha⁻¹ post-grazing, measured over five farms. These residuals increased when rainfall increased and underfoot conditions led to muddying of the feed during the grazing event. The resultant residuals provided a range of ground cover, which is important for maintaining surface tensile strength, interception of rainfall and slowing surface water flow speed (Silburn et al. 2011). Maintaining this ground cover helps reduce surface erosion significantly (Silburn et al. 2011).

Case Studies

A brief description of a range of case studies are presented to highlight the practical outcomes from these alternative wintering practices.

Case Study 1

Case study 1 used a mixed forage crop which included a range of traditional brassica species and additional regrowth elements such as Italian ryegrass and plantain. The crop was grazing during late summer with finishing lambs, removing an estimated 4 t DM/ha. The forages were subsequently spelled for grazing during the winter by mixed age ewes providing approximately 3330 grazing day equivalents per hectare and supporting a liveweight (LW) of 23.3 kg/m². Regrowth during the spring was unrecorded, though was used to support hogget liveweight gain at that time, before re-establishment of permanent pasture during late November. Regrowth components included Italian ryegrass and plantain. The primary winter crop component was Turnips.

Case study 2

This farm used an extensive multi-species mixture (Table 2 footnote), to feed wintering rising-2-year-old beef cattle of approximately 300-400 kg liveweight, with an expectation that some spring grazing may be available. Crop yield was relatively low with 92% being traditional kale and 8% the companion species (Table 2). Many of the companion species were summer annuals and had senesced, resulting in low contribution to winter feed supply. Approximately 5 t DM/ha was added as baleage (60% of the diet) to meet the feed demand (Table 2). Approximately 1200 grazing day equivalents/ha were achieved with a stocking density of 42.4 kg LW/m² (Table 2). Rainfall during this time (Table 2) was approximately 40% higher than the long-term average of approximately 280 mm. Under these wet soil conditions cattle hooves broke through the soil surface, removing ground cover and damaging soil structure (Figure 1b) to approximately 15 cm depth. Under these soil conditions the mixed forage option did not provide any amelioration of soil damage or animal welfare concerns, acting similarly to a traditional winter crop.





Figure 1 A mixed species crop before (a), directly after grazing (b) by rising-2-year-old cattle of approximately 300-400kg. Autumn rainfall totalled approximately 390 mm, higher than the long term average of 280mm.

Case study 3

This farm used a multi-species, multi-graze approach with forages being used in summer, autumn, winter and spring. The establishment of multi-species crop, which was sown as a general mixture of seed, allowed different species to establish in areas of the paddock where the brassica component did not (Figure 2). This benefited the system by providing a more consistent feed supply across the paddock, and protecting the soil, often on steeper and lower fertility parts of the paddock.

The bulk of the forage was utilised in winter with mixed age ewes of approximately 68 kg live weight with feed allocated to achieve feeding requirements for mid-late pregnancy. The estimates of 1.6 kg DM/day, (Table 2) are for late July for twin-bearing ewes. The crop provided approximately 4820 grazing day equivalents/ha and resulted in a stocking density of 32.9 kg LW/m². Rainfall of 340 mm during this time was greater than the long-term average of 270 mm and resulted in a relatively high post-grazing residual with much of the residual being trampled into the ground (Figure 2c)

During grazing the range of species evident (Figure 2) shows the residual of grasses and plantain. When grazing was complete (Figure 2c) the residual herbage mass is depleted (1980 kg DM ha⁻¹, Table 2) though still provides some protection for the soil and a residual stubble for regrowth.

This paddock recovered to provide feed for late-lambing twin-bearing ewes stocked at 8 ha⁻¹ from mid-September until December, with an estimated feed consumption of 2,310 kg DM ha⁻¹. Regrowth components included Italian ryegrass, plantain and ryecorn. The primary winter crop component was Kale.



Figure 2 A multi-species forage mixture before (a), during (b) and after (c) grazing by sheep on 6 July 2023. Estimated rainfall during autumn prior to grazing was 340 mm, higher than the long term average of 270mm.

Case Study 4

A multi-species mixture including Raphnobrassica, turnips and grasses, cereals and plantain (Figure 3) was grazing by mixed age ewes of approximately 65 kg liveweight, allocated to 1.59 kg DM/day to provide a diet to meet feed requirements during mid to late pregnancy (Table 1). This resulted in approximately 2900 grazing day equivalents/ha (Table 2) and achieved a residual herbage mass of 1400 kg DM/ha. This resulted in a stocking density of 20.3 kg LW/m². Estimated rainfall during autumn, prior to grazing was 330mm, greater than the long-term rainfall during this period of approximately 260 mm.



Figure 3 A multi-species forage mixture before (a) and after grazing (b) by sheep on 5 July 2023, and after 20 days of regrowth (c) and after grazing in November (d). Rainfall from 1 May until grazing on 5 July was estimated to be approximately 260 mm.

Once grazed a significant cover of the grasses remained (Figure 3b). This enabled the rapid recovery of the sward (Figure 3c). Regrowth components included Italian ryegrass, plantain, Prairie grass, and ryecorn. The primary winter crop component was Raphanobrassica. Subsequent grazing during the spring was by hoggets and farmer grazing records estimated that 1,900 kg DM/ha was consumed between August and November.

Case Study 5

This case study grazed weaner deer on a turnip and Italian ryegrass forage crop and compared this with the grazing of a traditional swede crop. The turnip/Italian ryegrass crop was grazed during winter to achieve winter liveweight gain targets for weaner growth. Four hundred weaners of approximately 85 kg liveweight were stocked on 13 ha. A total of 5.9 t DM ha⁻¹ was harvested (Table 2), winter liveweight gain of 10 kg head⁻¹ was achieved and feed lasted 65 days, or 1736 grazing day equivalents/ha. A stocking density of 14.8 kg LW/m² was achieved. This compared with a traditional swede crop which yielded 9.5 t DM ha⁻¹ (Table 2) and provided feed for 100 days or 4023 grazing day equivalents and a stocking density of 34.1 kg LW/m². Regrowth components included Italian

ryegrass. The primary winter crop component was Turnips. Regrowth during the following spring was approximately 2710 kg DM/ha after moderate winter damage.

Case Study 6

Bale grazing was done on a pasture where hay was made on 18 January 2023 and the pasture was left to recover until grazing. The area was grazed with 95 pregnant heifers of approximately 435 kg, over a 90-day period from 31 May until 30 August 2023. Cattle were shifted once every three days and were stocked at a rate of 250 ha⁻¹ within each break. The allowance of 9.47 kg DM/head/day resulted in 1008 grazing days per hectare and a stocking density of 45.4 kg DM/m². Rainfall during autumn prior to grazing (Table 2) was estimated to be approximately 395 mm, compared with the long-term average of 313 mm over that time. The old pasture helped keep the soil together during bale grazing (Figure 4). While individual hoof damage penetrated to approximately 15-20 cm (Figure 4), groundcover remained intact. The liveweight gain of these pregnant heifers using the bale-grazing system was 0.6 kg d⁻¹ over a 90-day period. Historical liveweight gain records on traditional crops was approximately 0.4 kg d⁻¹ over similar periods.



Figure 5 An example of bale grazing of 435 kg pregnant heifers on 1 August 2023 depicting conditions during grazing (a), and after grazing (b). Rainfall during autumn before grazing was estimated to be 395 mm, compared to the long-term average rainfall of 313 mm.

Case study reflections

Farmers identified creating less mud as the greatest benefit enabled by changing wintering practices. Moving away from traditional crops reduced the amount of mud (Figures 2, 3, 4) even when autumn rainfall prior to grazing was 20% greater than average. Less mud was also noted to reduce the physical effort required when erecting temporary fences. Using a break grazing system of blocks, rather than strips, grazing with 3–4-day grazing periods was noted to reduce stock movement and soil disturbance.

Mud in the diet has the potential to reduce feed intake by between 15 and 30% (NRC 1981) as well as load the diet with potential pathogens. Being confined onto muddy locations also increases animal maintenance requirements, particularly of cattle, by up to 40% (Nickles et al. 2022), and the total intake requirement in late pregnancy by 27%, due to greater heat loss under these conditions. Other consequences of exposure to mud include increased risk of infections (Concha-Bermejillo and Romano 2021, Mulvaney 2013) and reduced lying times which affect welfare (Dickson et al. 2022). The residual of dead material from some species such as ryecorn and forage oats (Table 3) remained un-eaten (Figure 2, 3, and 4), providing a barrier between the animals and the soil. This may provide the opportunity for animals to increase lying times due to the reduction in mud. Thus, the reduction in the presence of mud has the potential to provide a range of animal welfare and production benefits, including increased lying time, decreased disease risk, improved nutrition and decreased maintenance energy requirements.

Altering the profile of feed supply was a significant factor that needed managing within the farm system. Farmers utilised a range of stock classes to harvest the production of multi-species, multi-graze forages over an extended period. Often the mixtures need to be grazed during summer or autumn before the mixture components die off and lose feeding value (Dumbleton

et al. 2022). Regrowth which occurred from August to late October (Table 4) averaged 2,770 kg DM ha⁻¹ providing critical spring feed. Typically, the amount of forage recovery was greater and more consistent after sheep grazing, than deer or cattle grazing. The impact of sheep treading is much less than deer or cattle due to the lower liveweight of sheep.

Low winter yields were a feature of multi-species mixtures (Table 2). This is often because components of the mixture die and senesce at the end of summer and are therefore no longer available for grazing during winter (Case study 2). Farmers have adapted to this by shifting to a multi-graze approach. This, however, may leave a deficit in winter feed, unless the pasture that was not utilised when the multi-graze mixture was eaten is conserved for winter use. For example, grazing in April by ewes was estimated to remove 3.6 T DM ha⁻¹ in one case study. At that time this grazing released an area of pasture equivalent to 4.25 times the crop area. This needs to be recognised and set aside for winter feeding. The traditional winter crop continues to accumulate feed throughout the growing season with no further management decisions to make.

The practice of late sowing using spraying and direct drilling was used by all farmers. This approach can postpone the removal of pasture from grazing by 3–4 weeks compared with traditional winter cropping establishment methods. Often winter cropping uses approximately 5% of the farm area so altering sowing dates may provide an extra 5% to the intake of ewes with lambs at foot during the late September and October period when lactation outputs are at their highest. The reduction in bare soil exposure both before sowing and after the crops were utilised in winter was evident in the residual covers remaining after grazing (approximately 1500 kg DM/ha). Areas used by traditional winter crops may be out from pasture for 450 days, with up to 90–120 days of bare land during spring. Because this is over a year, it means that double the area of winter crop is unavailable to grazing during

early spring, so traditional practices then potentially remove another 5% from grazing at that time. All the alternative wintering practices increased grazing time on pasture during spring, both by late sowing and by spring regrowth, by up to 10% of the farmed area. The longevity of the Italian ryegrass was variable. If winter damage was significant then sowing to permanent pasture may be required later in spring. However, many of the sheep grazing case studies have extended the life of the Italian ryegrass through a second winter before sowing back to pasture.

Dietary balance was also identified by farmers as an advantage to changing to mixed forage options. Feed quality (Table 3) measurements indicated that the traditional crop components of the mixed forages were generally higher in ME and soluble sugars and lower in protein and fibre (NDF) than the remaining species. There were small differences between the bulb, leaf and stem components of the traditional winter forages, with Raphnobrassica having greater fibre content and lower energy content in the stems (Table 3).

Dietary transitions occur when an animal shifts from one feed source to another. It is particularly important when transitioning from pastures low in soluble carbohydrates and high in fibre onto winter forages

such as swedes, turnips and fodder beet which are high in soluble sugars and low in dietary fibre (Nicol et al. 2003). The use of multi-species mixtures provided diets that had moderate soluble sugars (WSC content of 20.7%) and dietary fibre (NDF content of 33.6%) due to the range of plant types included. This approach provided a diet that required little dietary transition with no observed animal health issues that are commonly associated with transitioning to traditional winter crops.

Macronutrients were lowest in the baleage, and often lower in bulbs than other forage components (Table 3). Of the micronutrients measured (Table 3), turnip bulbs had higher Zn but were lower than the multi-species mixture in Cobalt, Copper and Selenium. The micronutrient concentrations of the mixed forage were inflated by the presence of soil, as evidenced by the high Fe concentrations.

Farmers identified the increase in complexity which was required to balance the trade-offs created by the change in potential feed supply when using multi-grazing options. Traditional winter crops are simple to enact and execute, as they are established, monitored for disease and weeds and then fed out into a specific feed deficit, often at relatively stable yields. Multi-species, multi-graze mixtures and all-grass wintering

Table 3 Feed quality characteristics and macro and micro mineral content of a range of winter feeds including baleage, traditional crop components and multi-species forage mixtures.

	Baleage	Bulb	Crop Leaf	Crop Stem (Kale)	Crop Stem (Raphno)	Mixed Forage
ADF (%DM)	37.7	11.8	13.6	21.3	30.9	26.4
NDF (%DM)	65.8	15.2	17.1	27.6	37.5	47.8
Crude Protein (%DM)	9.9	13.9	21.4	11.0	8.5	20.2
Soluble Sugars(%DM)	1.5	47.4	21.9	32.5	24.6	9.1
Energy (MJ ME/kg DM)	6.8	14.4	13.4	12.4	10.6	10.0
Macromineral (% DM)						
Ca	0.54	0.44	2.29	0.70	0.68	0.85
K	0.87	2.75	2.62	2.68	2.87	2.58
Mg	0.16	0.11	0.20	0.17	0.13	0.17
Na	0.11	0.10	0.24	0.15	0.43	0.23
P	0.20	0.35	0.34	0.24	0.26	0.35
S	0.16	0.40	0.81	0.46	0.52	0.24
Micromineral (mg/kg DM)						
Co	0.08	0.10	0.07	0.04	0.02	0.47
Cu	4.67	1.50	2.83	1.75	1.33	8.16
Se	0.04	0.02	0.16	0.03	0.25	0.11
Zn	23	40	29	17	28	36
Fe	112	41	137	40	47	1551

add a significant amount of complexity to decision-making. This was added to already complex systems, where reducing complexity is often strived for. Thus, other benefits must be great enough for farmers to implement this system. Techniques such as 3-4-day shifting can ease pressure on labour and provide time for planning.

Farmers also acknowledged that greater management precision was required to ensure feed flows were managed to fill the winter feed deficit. Planning was required during autumn if a multi-graze crop was utilised then, to ensure spared pasture was set aside to meet winter feed demands. This also required a level of discipline in feed allocation at that time, avoiding the trap of using the spared feed to achieve other goals such as lamb finishing.

Conclusions

Farmers found that several changes needed to be made when implementing alternative wintering practices. These included a greater amount of forward planning, increased precision in management requirements, a consideration of the need to balance autumn and winter pasture supply and strategies to cope with lower winter crop yields.

The farmers highlighted benefits from a more balanced winter feed diet and less mud. These factors resulted in perceived improvements in animal welfare and potentially lower environmental impacts. The management of these alternative wintering practices also reduced winter labour requirements and provided multiple grazings, with greater farm area available for grazing in spring than when using traditional winter cropping options.

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REFERENCES

Concha-Bermejillo A de la, Romano J. 2021. Pregnancy loss in cattle. *Clinical Theriogenology* 13: 167-180. <https://doi.org/10.58292/ct.v13.9334>

Deer Industry NZ. 2015. Fusobacteriosis. <https://doodle.com/group-poll/participate/b4G6KG2a>. Retrieved 23 April 2024 from https://www.deernz.org/assets/Deer-Facts/DeerFact_Fuso_2015-09.pdf

Dickson EJ, Campbell DLM, Monk JE, Lea JM, Colditz IG, Lee C. 2022. Increasing mud levels in a feedlot influences beef cattle behaviours but not preference for feedlot or pasture environments. *Applied Animal Behaviour Science* 254: 105718.

<https://doi.org/10.1016/j.applanim.2022.105718>

Dumbleton A, Foley F, Westwood C, Box G. 2022. The development of Pallaton Raphanobrassica for New Zealand farming systems. *Journal of New Zealand Grasslands* 83: 107-114. <https://doi.org/10.33584/jnzg.2021.83.3505>

Judson H, McKenzie S, Robinson S, Nicholls A, Moorhead A. 2016. Measurement techniques and yield estimates of fodder beet in Canterbury and Southland. *Journal of New Zealand Grasslands* 78: 177-180. <https://doi.org/10.33584/jnzg.2016.78.502>

Kenyon PR, Morris ST, Stafford KJ, West DM. 2011. Effect of ewe body condition and nutrition in late pregnancy on the performance of triplet-bearing ewes and their progeny. *Animal Production Science* 51: 557-564. <https://doi.org/10.1071/AN10192>

Monaghan RM, Laurenson S, Dalley DE, Orchiston TS. 2017. Grazing strategies for reducing contaminant losses to water from forage crop fields grazed by cattle during winter. *New Zealand Journal of Agricultural Research* 60: 333-348. <https://doi.org/10.1080/00288233.2017.1345763>

MPI 2020. Winter Grazing Taskforce. Final Report and Recommendations. Retrieved June 2020 from <https://www.agriculture.govt.nz/dmsdocument/38210-Winter-Grazing-Taskforce-Final-report-with-appendices-included.pdf>. 33pp.

Mulvaney C. 2013. A guide to the management of footrot in sheep. Retrieved 23 April 2024 from <https://beeflambnz.com/knowledge-hub/PDF/nz-merino-and-blznz-guide-management-footrot-sheep.pdf>.

National Research Council. 1981. Effect of environment on nutrient requirements of domestic animals. National Academy Press, Washington, DC. <https://doi.org/10.17226/4963>

Nickles KR, Relling AE, Garcia-Guerra A, Fluharty FL, Kieffer J, Parker AJ. 2022. Beef cows housed in mud during late gestation have greater net energy requirements compared with cows housed on wood chip bedding. *Translational Animal Science* 6: 1-14. <https://doi.org/10.1093/tas/txac045>

Nicol W, Westwood C, Dumbleton A, Amyes J. 2003. Brassica wintering for dairy cows: overcoming the challenges. Presented at: South Island Dairy Event (SIDE). Canterbury, New Zealand. 154-172.

Silburn DM, Carroll C, Ciesiolka CAA, deVoil RC, Burger P. 2011. Hillslope runoff and erosion on duplex soils in grazing lands in semi-arid central Queensland. I. Influences of cover, slope, and soil. *Soil Research* 49: 105. <https://doi.org/10.1071/SR09068>.

Simon P, Cumming R, Smith LC, Srey F, Rutherford A, Monaghan RM. 2024. The environmental performance of a ryegrass and baleage wintering

- system on a poorly drained soil in southern NZ. *Journal of New Zealand Grasslands* 86: 145-160. <https://doi.org/10.33584/jnzg.2024.86.3701>
- Stevens D, Canton M, Harpham S. 2021. Farming with reduced winter cropping in southern New Zealand: the risks and practicalities. *Journal of New Zealand Grasslands* 83: 123-134. <https://doi.org/10.33584/jnzg.2021.83.3500>
- Stevens DR, Casey MJ, Scandrett JS, Baxter GS. 2011. Winter feeding – changing labour requirements and productivity. *Proceedings of the New Zealand Grassland Association* 73: 51-56. <https://doi.org/10.33584/jnzg.2011.73.2850>
- Thompson BR, Stevens DR. 2012. A comparison of the intake of cows grazing swedes and kale and consequent condition score changes. *Proceedings of the New Zealand Grassland Association* 74: 63-68. <https://doi.org/10.33584/jnzg.2012.74.2895>