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Ministry for Primary Industries
Manatū Ahu Matua

From winter forages to pasture: a technical manual

Layout

This technical manual provides some insight into the range of practices that utilise some multi-graze, multi-species forage options that may assist in reducing environmental impacts and increasing animal welfare outcomes. It is laid out in three sections.

Motivation – a section defining why farmers are testing alternative options for feeding livestock during winter.

Practice – here we describe the types of practice that are being employed.

Outcomes – How successful are these outcomes? How do they contribute to feeding livestock, improving animal welfare and reducing potential environmental impacts.

Case studies – photographic records of winter grazing outcomes.

Motivation

We asked farmers to define why they wanted to move away from traditional winter cropping systems for feeding livestock. These motivations were in four themes:

Looking after people during winter

- Working conditions are harsh.
- The work feeding out crops is hard and time consuming.
- Poor animal welfare outcomes affect morale.
- Poor environmental impacts affect morale.

Looking after the animals

- Keeping animals out of mud
- Keeping animals well fed
- Minimizing animal losses

Looking after the environment

- Reducing sediment loss
- Maintaining healthy soils
- Meeting regulatory requirements

Reducing chemical inputs

Looking after the farm

Maintaining social licence to farm

Demonstrating good practice to consumers

Keeping costs down

Optimising animal production

Reducing risk to production systems both on and off farm

Practice

We followed a range of practices over three years to help define the role of a range of winter-feeding options. Feeding options explored were:

Conventional winter forage crops.

All-grass wintering.

Multi-species, multi-graze forage mixtures.

Bale-grazing.

A sample of these feeding options were fed to sheep, cattle and deer.

Feeding options

The winter-feeding options and the livestock they were fed to are in the following table.

Table 1: Examples of multi-species/multi-graze forage mixtures chosen by farmers in Southern New Zealand

Example	Forage mixtures	Animal
1	Kale, Turnip, Swedes, Italian ryegrass, Plantain, Phacelia	Sheep
2	Kale, Turnip, Italian ryegrass, Oats, Phacelia, Balansa clover, peas, Faba beans[1]	Cattle
3	Kale, Italian ryegrass, Plantain, Faba beans, Peas, Phacelia, Crimson clover, Persian clover[2]	Sheep
4	Raphnobrassica, Swede, Leafy Turnip, Italian ryegrass, Ryecorn, Plantain	Sheep
5	Raphnobrassica, Italian ryegrass, Prairie grass, Plantain, white clover, red clover	Deer
6	Perennial pasture/Bale grazing	Cattle
7	Turnips, Italian ryegrass	Deer
8	All-grass wintering	Sheep

[1] This mix also included Quinoa, Crimson clover, Lentils, Buckwheat, Lupins, Common vetch, Sunflower and Millet. These components did not contribute significantly to winter yield.

[2] This mix also included Vetch, Buckwheat, and Sunflower. These components did not contribute significantly to winter yield.

Management practices

Option choice

Choosing which winter-feeding option is about matching livestock class to feed requirements to soil type and landscape. That is why there were a range of options used. Each option has strengths and weaknesses and many of these are documented in the 'Outcomes' section. Using multi-graze options also requires some forward planning to capture the value of the mixture appropriately. Factors to consider are included in the 'Grazing' Section.

When choosing multi-species, multi-graze options the following traits of the mixture should be considered. A functional multi-species forage mixture will include:

- A high-yielding brassica for bulk (e.g. kale, swedes or turnips)
- One or two pasture grasses with cool-season activity (e.g. Italian ryegrass or Prairie grass)
- One or two cereal grasses for bulk, fibre and bedding (e.g. ryecorn or oats)
- Some legumes for feed quality and nitrogen fixation (e.g. peas, faba beans or clovers)
- Other species may be included for environmental reasons (e.g. plantain to help reduce potential nitrate leaching)

Pre-planning

Pre-spraying in the year before may need to control perennial weeds, especially Californian thistles. The farmer needs to ensure enough time between chemical application and sowing if using chemistry that will affect the mixture components. The technique of carpet rolling can reduce risk and increase effectiveness by using chemicals like Versatil, without broadcast spraying.

Establishment

Direct drilling is most often used to establish multi-species mixtures, to minimise soil disturbance and maintain soil strength. Practice includes spraying on day 0 and drilling on day 1, with no second spray and no waiting. However, good cultivation and chemical use practices will vary depending on the requirements of the site and the region. Spraying and drilling are targeted when soil temperature is greater than 15^{o}C. Spraying is targeted to days when there is no rain and after dew has gone off to maximise chemical effectiveness. Soil temperature is targeted to ensure good growth of the target species for chemical uptake, and good soil temperatures for reliable and rapid germination of the sown seeds.

Using a single spray approach, the timing of the traditional first spray is removed, meaning the paddock is available for grazing for 3-6 weeks longer if necessary. Alternatively, an early spray can be used to conserve soil moisture in dry environments as per local practices.

Sowing has been done by a range of methods. With the combination of a range of seed sizes a drill with a sponge disk delivery system (one side fluted) enabled the sowing of different size seeds. Some broadcast-applied small seeds, after drilling the larger seeds, followed by harrowing and rolling of the area, immediately post-sowing.

Management

Multi-species mixtures generally have no follow-up chemical use. Rapid germination, combined with the number of plant species used, reduced establishment of weeds, reducing the need for further herbicide treatments. Lower weed infestation is acknowledged as an outcome of using mixed plant species in cropping systems.

Combining several forage plants into a single mixture may also reduce the population of pest insects. Farmer observations supported this concept with no pesticide use being used on any of the multi-species mixtures. Generally, farmers noted less severe impacts of pest presence, potentially due to the range of plant species present, limiting the overall impact of an attack to a single component among many.

Grazing

Two considerations need to be made when grazing. The first is to capture the value of the multi-grazing nature of multi-species mixtures. Some species within these mixtures are annuals with no regrowth potential, so need to be utilised before their feeding value is lost. The second is to ensure grazing practices are balanced between efficient current utilisation and allowing growth for further future grazing.

The opportunity to utilise the multi-graze forage mixtures across a broad time frame may be used to ameliorate the impacts of low pasture growth during summer and autumn, or to capture feeding value of the mixtures during summer and autumn.

The grazing management approach of choice is to use a 3-4 day grazing period for all winter grazing practices. This has been demonstrated to settle animals and reduce animal treading damage to pastures, resulting in increased regrowth potential.

Inclusion of components like Italian ryegrass or Prairie grass will provide growth during spring. This can be used by any combination of livestock, with stocking rates dependant on stock class and required livestock performance.

Post-winter management

Multi-species, multi graze forages provide the opportunity for further grazing during the spring. This depends on the winter grazing conditions and the components of the mixtures. The potential outcomes are documented in the 'Outcomes' section.

Care must be taken to ensure that the future potential of multi-graze forages is not over-estimated. Plant losses during winter will reduce spring production. While the use of Italian ryegrasses will prolong the grazing window into spring, often the residual plant numbers will not be great enough for production beyond mid-to-late spring. Planning should ensure that perennial pastures are established during the late spring summer after the mixture is used.

A combination of grazing, glyphosate spraying and mulching is used to remove residual herbage before pasture renewal. Some small amount of top working may also be involved if the soil surface requires it (rare).

Outcomes

Farmer observations and some measurements were used to inform the advantage and disadvantages of the choices made. These choices have been pooled into four areas that relate to the original motivations of the farmers, including People, Animal welfare, Environment and Farm systems (Table 2).

Table 2: Advantages and disadvantages of altering winter feeding practices, including the addition of multi-species, multi-graze forage options, bale grazing and all-grass wintering.

Parameter	Characteristic	Direction of change	Attribute
People	Labour	+	Change to 3 to 4 day shifting reduces labour and weekend work
		+	Shift from heavy crops with mud reduces effort required to erect temporary fencing
		+	Less frequent shifting makes planning and scheduling of events more efficient
	Mental health	+	Less mud
		+	Animals more content
		+	Sediment loss less evident
Animal welfare	Feed supply	+	Available to meet deficits over a wider range of times and conditions
		-	Less feed directly available in winter
	Internal parasites	+	Increased interval between drenching for lambs
	Mud in diet	+	Less mud ingested
	Mud underfoot	+	Less potential foot problems
	Comfort		Residual dead material provides potential bedding
	Foetal loss	+	Foetal loss in cattle reduced from 3-5 per 100 cows to 0
	Liveweight gain	+	Pregnant cattle winter liveweight gain increased from 0.4 to 0.6 kg/d
		+	Weaner deer winter liveweight gain targets reached in 65 days
	Dietary transition impacts	+	Mixed diet avoids the need for additional fibre or protein
Environment	Groundcover	+	Residual forage reduces rainfall energy impact
	Soil exposure	+	Less soil Is exposed to movement during rainfall events
	Soil disturbance/damage	+	Soil strength is retained
	Nitrogen capture in recovery growth	+	Regrowing forage captures deposited nitrogen
	Redistribution of nitrogen loadings in soil	-	Multiple grazing, especially in autumn, may deposit nitrogen that may leach
	Nitrate mitigation	+	Addition of plantain with known performance in reducing nitrate leaching
	Chemical use	+	Lower herbicide use due to susceptibility of mixture components
		-	Some pre and post cropping herbicides may be needed
		+	Lower pesticide use
Farm systems	Cost of imported feed	+	Use during adverse weather will reduce the need for imported feed
	Cost of establishment	-	Seed costs may increase,
		-	More forage area may be needed
		+	Herbicide cost may decrease
		+	Use of legumes reduces nitrogen fertiliser requirements
	Altered feed supply	+	Feed available in all seasons depending on requirements
		+	Consistency in animal performance
		-	Exposure to less winter feed
	Transition between pasture-crop-pasture	+	Less bare soil time and non-productive time
		+	Less paddock preparation leads to more grazing before sowing
	Area	+	More area available for grazing
		-	More area of cropping due to lower yields and greater off-winter use
	Complexity	-	Increased complexity in matching feed to livestock throughout the year
	Management precision	-	Greater precision is required to manage changes in feed flows

People

Looking after people was a primary motivation for changing winter practices. Benefits came both from the management methods and the actual wintering practices.

Shifting to 3-4 day grazing periods enabled a reduction in workload and time for further planning. This also enabled a reduction in weekend work requirements. Moving away from traditional crops also reduced the amount of mud and so reduced the physical effort required when erecting temporary fences.

Greater peace of mind was also generated as farmers reported being more confident that livestock were well fed and that sediment losses were less evident. Lower stock losses were also listed as having a positive effect on morale.

Animal welfare

Eight attributes were identified during the project. These included feed supply, internal parasites, mud, both in the diet and underfoot, foetal loss, liveweight gain, dietary transition and comfort (Table). Altering feed supply may have both positive and negative effects on animal welfare. The flexibility of feed supply was used to offset the impacts of drought in two of the case study farms, providing feed during summer and autumn when pasture supply was limited. However, this utilisation of feed at non-traditional times can also compromise feed availability during winter. This may become an animal welfare issue if livestock cannot be fed adequately during winter. This issue is further discussed in the Farm Systems section.

The exposure to internal parasites is an ever-present challenge for farmed livestock. Faecal egg counting of lambs in example 3 provided evidence to extend the use of anthelmintic drenching from 4-week to 6-week intervals while grazing the multi-species forages. This demonstrates a lower burden of internal parasites, and thus a lower stress on the animal during this time. It also translates into a reduced chemical footprint for these farms.

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. Thus, it has a significant impact on the welfare of the animal when attempting to meet dietary requirements during winter. Further to this, being housed on mud increases the maintenance requirements, particularly of cattle, by up to 40% (Nickles et al. 2022), and the total intake requirement in late pregnancy by 27%. This is because of the greater heat loss under these conditions. Continual contact with mud can also increase the risk of foot problems due to bacterial infections such as footrot (Mulvaney 2013) and fusobacteriosis (Deer Industry NZ 2015). Finally, when offered choice, cattle prefer to rest on pasture rather than mud and increasing depth of mud reduces lying time (Dickson et al. 2022). Observations by the farmers indicated that a residual of dead material from some species such as ryecorn and forage oats remained uneaten, 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 risk of disease, better nutrition and decreased maintenance energy use.

A reduction in late pregnancy foetal loss in cattle, compared to historical data, was reported in one case study. The causes of late pregnancy foetal loss can be attributed to a wide range of potential causes, including campylobacter, leptospirosis and listeriosis to name a few (Concha-Bermejillo and Romano 2021). Many of these potential causes can reside in soil and may present a greater danger to cattle when wintered on traditional crops than options with a decreased soil intake.

Positive effects of liveweight change were measured in two case studies during winter. In one instance the liveweight gain of pregnant 3-year-old heifers using a bale-grazing system of 0.6 kg/d over a 90-day period was recorded. Historical liveweight gain records on traditional crops was approximately 0.4 kg/d over similar periods. In the second case study the liveweight gain of weaner deer on winter crops was approximately 100 g/d over 100 days while those grazing an Italian ryegrass/turnip mixture grew at approximately 150 g/d over a 65-day period. These differences may be due to several factors. In the case of the cattle, greater exposure to mud may be a major factor as soil ingestion reduces intake (NRC 1981) and living in mud increases maintenance feed requirements (Nickles et al. 2022). The nutritional density of the diet can also influence liveweight gain and this may be a factor in higher liveweight gain in the weaner deer. Stevens et al (1994) reported gain in hoggets grazing a mixed swede/Italian ryegrass forage during winter compared with a traditional swede crop of 132 and 40 g/d respectively, with associated increases in feed intake and dietary protein intake.

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 (Westwood and Nicol 2009). 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 transition to traditional winter crops.

Environment

The multi-species mixtures, and the bale grazing for beef cattle, resulted in a residual herbage mass of between 1500 and 1700 kg DM/ha post-grazing. This provided ground cover, which is important in 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). Traditional winter crop use results in complete groundcover loss. An exception to this result was observed with cattle grazing on saturated soils in case study 3. Rising 2-year-old cattle of approximately 300-400 kg LW were grazed on a multi-species mixture. Rainfall during the period 1 June 2023 to 31 July 2023 was 275mm, resulting in saturated soils. Under these soil conditions cattle broke through the surface removing groundcover and damaging soil structure. Soil saturation results in a significant reduction in soil strength leading to potential damage by heavy animals (Laurenson and Houlbrooke 2016).

The use of multi-graze mixtures has both potential positives and negatives for nitrogen deposition and recovery. After grazing during winter, the regrowth from the forage mixtures contributed between 2 and 4 t/ha to spring feed requirements, had a nitrogen concentration of 3.4%, and captured between 68 and 136 kg N/ha. If the multi-grazed forages were utilised during the autumn this deposits nitrogen onto the soil that may either be used by continued growth of the forage mixture or be available for leaching. The impacts of autumn grazing of these multi-graze, multispecies mixtures on potential nitrogen leaching are yet to be fully explored.

Four case studies included plantain in the forage mixtures. Plantain is proven to reduce nitrate leaching when included in pasture mixtures (Carlton et al. 2019) with greater reductions as the proportion of plantain in the mixture increases (Nyugen et al. 2022). The inclusion of plantain in these mixtures may aid in the reduction of nitrate leaching.

Reducing chemical use was one of the stated aims of the farmers involved in this study. The use of multi-species mixtures restricts the type of chemicals that may be used for weed control. Most farmers chose to use a single spray defoliant process, often with glyphosate, followed by forage sowing approximately 24 hours later. Soil temperatures were monitored in Case study 6 and sowing only occurred when soil temperatures were above 15°C, resulting in rapid germination. When combined with the number of plant species used the immediate weed burden was minimal, reducing the need for further herbicide treatments. Lower weed infestation is acknowledged as an outcome of using mixed plant species in cropping systems (Malezieux et al. 2008).

One exception to this was infestation with Californian thistle (*Cirsium arvense*). This weed was relatively unaffected by the establishment defoliation and went on to become a significant weed in 4 of the case study farms. Control techniques such as mowing and weed wiping were used. Weed wiper use involves low amounts of chemicals and targets only the thistles, keeping chemical use low. Broadacre spraying may be required in the future for thistle control and may result in restoring previous chemical use.

Combining several forage plants into a single mixture may also reduce the population of pest insects (Malezieux et al. 2008). Farmer observations supported this concept with no pesticide use being used on any of the multi-species mixtures, except slug control at sowing. Generally, farmers noted less severe impacts of pest presence, potentially due to the range of plant species present, limiting the overall impact of an attack to a single component among many. On-going monitoring is advised to manage potential pest outbreaks.

Farm Systems

Simple opportunities arose from using multi-species mixtures. These included lower cost of imported feed when faced with summer/autumn drought. This was also noted in some cases if bought-in feed was required when transitioning animals onto crops such as kale and fodder beet.

Establishment costs were reduced by the reduction in use of chemicals, though seed cost may also increase depending on the number and sowing rate of the range of species within a mixture. Often yields were lower than traditional winter crops, leading to the potential for a greater area to be sown in multi-species mixtures. This then had the potential to negate other cost savings. Often the overall cost of cropping was unaffected by changing practice.

Legume use to fix nitrogen and therefore reduce cost associated with N fertiliser use was often cited. The magnitude of this affect is not well documented. Some studies suggest that approximately 30-40 kg N may be transferred from legumes to adjacent crops, though this depends on the yield of the legume, and may be overstated for these mixtures.

Altering the profile of feed supply is a significant factor that needs managing. Farmers can harvest the production of multi-species, multi-graze forages over an extended time period. Often the mixtures need to be grazed during summer or autumn before the mixture components die off and lose feeding value. Some of the mixture components also maintain greatest productivity (e.g. Italian ryegrass, rapes and raphnobrassica) with some grazing (e.g. Dumbleton et al. 2022).

Feed supply in spring is particularly important for grazing systems. Estimates of spring grazing attained from multi species crops range from no grazing if winter grazing disrupts soil badly to up to 3,500 kg DM/ha. Typically the amount of forage recovery is greater and more consistent after sheep grazing, than deer or cattle grazing, as sheep treading damage is less due to the liveweight of the animal. Spring stocking rates of between 0.5 and 0.8 of that of pasture may be expected after sheep grazing.

Often winter forage crops are high in energy, though may be deficient in protein and fibre, as well as minerals and trace elements (Stewart et al. 2022). The use of multi-species mixtures generally improves the balance of nutrients (Table 3), reducing requirements to add extra feed for dietary transition and diet balancing (such as added fibre and protein). The protein and NDF contents, for example, meet nutritional and digestive health requirements in the multi-species mixtures, but not in the turnip bulb. This improved balance of dietary nutrients increases the consistency of stock performance.

Table 3: Some feed nutrient contents for Turnip bulb and whole multi-specie mixtures fed in winter. Average of five crops measured in 2023.

	Turnip bulb	Multi-specie mixtures
Energy (MJME/kg DM)	13.0	11.3
Protein (g/100g DM)	9.2	16.8
NDF (g/100g DM)	17.6	33.6
Soluble sugars (g/100g DM)	47.2	20.7
Calcium (g/100g DM)	0.44	1.12
Phosphorus (g/100g DM)	0.35	0.33
Magnesium (g/100g DM)	0.11	0.17
Cobalt (mg/kg DM)	0.10	0.19
Copper (mg/kg DM)	1.5	5.0
Selenium (mg/kg DM)	0.02	0.10
Zinc (mg/kg DM)	40.0	28.2

Low crop yields are often a feature of multi-species mixtures (Table 4). 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. Farmers have adapted to this by shifting to a multi-graze approach. This, however, may leave a deficit in winter feed, unless the pasture which was not utilised when the multi-graze mixture was eaten is stockpiled for winter use. For example, grazing in April by ewes was estimated to remove 3.6 t DM/ha 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 to result in a transfer of large quantities of feed into the winter.

The practice of late sowing, coupled with the regrowth during the spring results in less bare soil time both before sowing and after the crop is utilised in winter. Traditional winter crops may occupy land for 450 days, with up to 90-120 days of bare land during spring. Late sowing of the mixtures means that grazing time on pasture during spring is increased. This is also the case after winter when pasture species such as Italian ryegrass and plantain regrow. The longevity of the Italian ryegrass is variable. If winter damage is 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.

The area used for cropping can be greater than that required for traditional winter crops. However, because the area has multiple uses and can be grazed in spring, the average area is not affected as greatly. For example, with a time out of pasture of 450 days, this spreads effective loss of area over 2 years, having the impact of increasing a traditional cropping area of what would be considered 5% of the total farm to being 8.5%. This under-accounting is common. The area required to replace this nominal 5% was 10% in one case study, creating a difference of only 1.5% when the time out of pasture is considered. This highlights the difference between cash costs of practices such as establishment and pasture renewal (which would be incurred on 5% or 10% of the farm area) and opportunity costs from having land out of grazing (such as lower stocking rate or underperformance of stock if feed is restricted).

Table 4: Winter feeding options chosen by the six farmers in the study and the animal type to which they were fed.

Forage mixtures	Winter Crop yield (kg DM/ha)	Animal
Kale, Turnip, Swedes, Italian ryegrass, Plantain, Phacelia (*Phacelia tanacetifolia*)	7,100	Sheep
Kale, Turnip, Italian ryegrass, Oats (*Avena sativa*), Phacelia, Balansa clover (*Trifolium balansae*), peas, Faba beans[1]	8,400	Cattle
Kale, Italian ryegrass, Plantain, Faba beans, Peas, Phacelia, Crimson clover (*Trifolium incarnatum*), Persian clover (*Trifolium resupinatum*)[2]	9,700	Sheep
Raphnobrassica, Swede, Leafy Turnip (*Brassica rapa*), Italian ryegrass, Ryecorn (*Secale cereale*), Plantain	6,100	Sheep
Raphnobrassica, Italian ryegrass, Prairie grass, Plantain, white clover (*Trifolium repens*), red clover (*Trifolium pretense*)	nd	Deer
Perennial pasture/Bale grazing	10,500	Cattle
Turnips, Italian ryegrass	5,900	Deer

[1] This mix also included Quinoa (*Chenopodium quinoa*), Crimson clover, Lentils (*Lens culinaris*), Buckwheat (*Fagopyrum esculentum*), Lupins (*Lupinus albus*), Common vetch, Sunflower (*Helianthus annuus*) and Millet (*Pennisetum glaucum*). These components did not contribute significantly to winter yield.

[2] This mix also included Vetch, Buckwheat, and Sunflower. These components did not contribute significantly to winter yield.

Using multi-species, multi-graze crops leads to increasing complexity. Traditional winter crops are simple to enact and execute. Crops 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 add a significant amount of complexity to decision-making. This is 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. Bale grazing provides the opportunity for forward planning and surety of winter feed supply in much the same way as traditional crops.

Further to this the level of management precision is increased to ensure feed flows are managed to fill the winter feed deficit. Planning is required during autumn if a multi-graze crop is utilised then, to ensure spared pasture is set aside to meet winter feed demands. This also requires 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.

The advantages and disadvantages of shifting away from traditional winter crops are significant. However, the impacts of increasing complexity and need for greater management precision are the most serious. Farmers will need to acknowledge the significance of the benefits within their own system and utilise techniques such as direct drilling, late sowing and 4-day shifting to provide space to encompass the extra complexity and management precision that is required.

Case studies

Farm 1: This farm employed an extensive multi-species mixture, aimed at wintering beef cattle, with an expectation that some spring grazing may be available.

Farm 2: This farm used a multi-species, multi-graze forage mixture to provide feed during late summer for lamb finishing, winter and spring for ewes.

Farm 3: A mix of traditional crops with some added forage species and multi-species, multi-graze forage mixture was fed to sheep. Some post-grazing catch cropping was also employed.

Farm 4: Two examples are presented here. These include the feeding of finishing deer (rising-1-year-old) on forage mixture of turnips and Italian ryegrass and the wintering of pregnant cattle (rising-3-year-old heifers) on autumn-saved pasture and hay.

Farms 5 and 6: These farms were part of a study comparing 1-day and 4-day shifting on an all-grass wintering system.

Photographic records of winter grazing conditions

Photographic records of the crops were taken during the winter grazing period. A comparative sample of those photographs is presented here. They provide an illustration of the condition of the crops before and after grazing.

Case Study Farm 1:

a)

b)

 c)

Figure 1: A mixed species crop before (a), directly after grazing (b) by rising-2-year-old cattle of approximately 300-400kg and in November (c) after 3 months of recovery. Rainfall from 1 May until grazing on 5 July totalled approximately 366 mm.

Figure 1 demonstrate the impact of cattle when grazing on saturated soils. These soils were disturbed to approximately 15 cm depth. The measurement of a residual herbage mass after grazing was deemed infeasible, though a small amount of groundcover was present in some areas (Figure 1c). Figure 2 provides a representation of the same crop when utilised by sheep in the same conditions. The paddocks represented in Figures 1 and 2 were within 100 m of each other. The opportunity for the multi-graze species to recover in Figure 2 will be much greater than in Figure 1 due to the lower soil disturbance and the remanent forage cover. Rainfall during this time was greater than the long-term average of approximately 280 mm.

Figure 2: A mixed species crop after grazing by sheep of approximately 70 kg liveweight. Rainfall from 1 May until grazing on 5 July totalled approximately 366 mm.

Case study farm 2

Figure 3 shows a multi-species crop before and after grazing with sheep. Of note in the pre-grazing photograph (Figure 3a) are the areas of grasses which establish in areas of the paddock which the brassica component did not. This was highlighted as a significant benefit for farmers by providing a more consistent feed supply across the paddock, and protecting the soil, often on stepper and lower fertility parts of the paddock. Rainfall during this time of 260 mm was similar to the long-term average of 270 mm

During grazing the range of species is evident (Figure 3b) with a residual consisting mostly of grasses and plantain. When grazing was complete (Figure 3c) the residual herbage mas is depleted (measured at approximately 1400 kg DM/ha, Table 1) though still provides some protection for the soil and a residual stubble for regrowth. This paddock recovered to provide feed for twin-bearing late-lambing ewes stocked at 8/ha from mid-September until December, with an estimated feed consumption of 2,310 kg DM/ha.


a)


b)

c)

Figure 3: A multi-specie forage mixture before (top), during (middle) and after (bottom) grazing by sheep on 6 July 2023. Estimated rainfall from 1 May to the grazing date of 6 July was 260 mm.

Case Study Farm 3

Case study 3 farm grazed a multi-species mixture with mixed age ewes of approximately 65 kg liveweight. Estimated rainfall was similar to the long-term rainfall during this period of approximately 257 mm. Figure 4 provides a record of the state of the crop before grazing indicating the contribution of the Raphnobrassica and the associated grasses and plantain.

a)

b)


c)


d)

Figure 4: 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 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. This enabled the rapid recovery of the sward seen in Figure 4c. This recovery growth was not measured. Subsequent grazing during the spring was by hoggets and an estimated 1,900 kg DM/ha was consumed between August and November with the sward condition being represented in Figure 4d.

Case Study Farm 4

This case study farm provided two examples. The first was weaner deer on a turnip and Italian ryegrass forage crop, and the second used bale grazing on old pasture to feed pregnant heifers.

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 was harvested, winter liveweight gain of 10 kg/head was achieved and feed lasted 65 days. This compared with a traditional swede crop which yielded 9.5 t DM/ha and provided feed for 100 days.

Figure 5 compares the soil conditions of the turnip/Italian ryegrass mixture with a traditional swede crop. The Italian ryegrass provided approximately 1.9 t DM/ha of the 5.9 t DM/ha yield (Figure 5a). Some damage was evident after grazing (Figure 5b), while Italian ryegrass regrowth continued throughout winter and spring. The subsequent ground cover of the Italian ryegrass (Figure 5c) was too low, and a permanent pasture was sown in late spring.


a)


b)


c)


d)

Figure 5: Examples of a turnip/Italian ryegrass forage mixture fed to weaner deer on 8 June 2021 depicting conditions before grazing (a), after grazing (b) and on November 8 2021 (c). Rainfall from 1 May until the grazing date of 8 June was estimated to be 110 mm. Also included is a post-grazing representation of traditional swede crop (d).

Bale grazing was done on a pasture where hay was made on 18 January 2023 and the pasture was left to recover until grazing, with 95 rising-3-year-old pregnant heifers of approximately 435 kg, over a 90-day period from 31 May until 30 August 2023. Photographs were taken during sampling on 1 August 2023. Rainfall from 1 May until 1 August was estimated to be approximately 420 mm, compared with the long-term average of 297 mm over that time.

Figure 6 demonstrates the ameliorating effects of the old pasture during bale grazing. The amount of feed on offer was measured to be approximately 10,550 kg DM/ha including pasture and baleage. Cattle were shifted once every three days and were stocked at a rate of 250/ha within each break. While individual hoof damage penetrated to approximately 15-20 cm the photographs show the intact groundcover over the area. The area in Figure 5a slopes downhill from right to left with little sign of sediment movement downslope into the next grazing area.


a)

b)

c)

Figure 6: Examples of bale grazing of 435 kg rising-3-year-old pregnant heifers on 1 August 2023 depicting conditions during grazing (a), after grazing (b) and after 10 days of regrowth (c). Rainfall from 1 May until the grazing date of 1 August was estimated to be 420 mm.

Case Study Farms 5 and 6

This case study comes from a previous project, ‘No More Bearings’, which investigated 1-day compared with 4-day shifting of sheep on an all-grass system during winter. Two examples of pasture conditions after grazing show that the 4-day grazing approach reduced pasture damage (Figure 7). The same allowance, to meet maintenance and pregnancy feed requirements, was provided to all mobs. The only difference was the instantaneous stocking rate, as a 4-day grazing regime effectively reduces the stocking rate to 25% of the 1-day shifting regime.


a)


b)


c)


d)

Figure 7: Examples of the condition of winter pasture on a farm in Hedgehope (a,b) and Orepuki (c,d), Southland, after a 1-day grazing (a,c) or a 4-day grazing (b,d) over the same periods in winter 2010.

References

Carlton AJ, Cameron KC, Di HJ, Edwards GR, Clough TJ. 2019. Nitrate leaching losses are lower from ryegrass/white clover forages containing plantain than from ryegrass/white clover forages under different irrigation, *New Zealand Journal of Agricultural Research, 62:2*, 150-172, DOI: 10.1080/00288233.2018.1461659

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://www.deernz.org/assets/Deer-Facts/DeerFact_Fuso_2015-09.pdf accessed 23 April 2024.

Laurenson, S., Houlbrooke, D., 2016. Identifying critical soil water thresholds to decrease cattle treading damage risk. *New Zealand Journal of Agricultural Research 59*: 444–451. https://doi.org/10.1080/00288233.2016.1223147.

Malézieux, E., Crozat, Y., Dupraz, C. Laurans M, Makowski D, Ozier-Lafontaine H, Rapidel B, de Tourdonnet S, Valantin-Morison M. 2009. Mixing plant species in cropping systems: concepts, tools and models. A review. *Agronomy for Sustainable Development 29*: 43–62 (2009). https://doi.org/10.1051/agro:2007057

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

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

Nguyen, T.T., Navarrete, S., Horne, D.J., Donaghy, D.J., and Kemp, P.D. 2022. Effect of plantain content in ryegrass-based dairy pastures on nitrate leaching and key components of the nitrogen cycle. In: Adaptive Strategies for Future Farming. (Eds. C.L. Christensen, D.J. Horne and R. Singh). http://flrc.massey.ac.nz/publications.html.

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. Pp. 154-172

Silburn, D.M., Carroll, C., Ciesiolka, C.A.A., deVoil, R.C., 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.

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 D, Casey M, Bennett C. 2022. From winter crops to pasture: Wintering forage choices and monitoring protocols (2023). Report to MPI.

Stevens D, Casey M. 2022. From winter crops to pasture. Farmer and Agribusiness workshops 2022. Report to MPI.

Stevens D, Casey M. 2023. Impacts of forage cropping decisions on feed flows in cool-temperate grazing systems: Sheep and beef. Report to MPI.

Stevens D, Casey M. 2023. Impacts of forage cropping decisions on feed flows in cool-temperate grazing systems. *Proceedings of the XXV International Grassland Congress https://uknowledge.uky.edu/igc/XXV_IGC_2023/Livestock/87/*

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

Stevens DR, Turner JD, Gowers S, Baxter G, Armstrong SD. 1994. Improving hogget performance through efficient management of the spring surplus. *Proceedings of the New Zealand Grassland Association 56*: 85-90. https://doi.org/10.33584/jnzg.1994.56.2138

Stevens, D, Casey M, Bennett, C. 2022. From winter crops to pastures: Winter and spring sampling 2022. Report to MPI.

Thompson BR, Stevens DR, Knowles I. 2010. Investigating the potential of kale to remove soil potassium accumulated from farm dairy eluent application. *Proceedings of the New Zealand Grassland Association 72*: 263-268. https://doi.org/10.33584/jnzg.2010.72.2793

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

Wall AJ, Stevens DR, Thompson BR, Goulter CL. 2012. Winter management practices to optimise early spring pasture production: a review. *Proceedings of the New Zealand Grassland Association 74*: 85-90. https://doi.org/10.33584/jnzg.2012.74.2888