

Animal performance over 16 years after implementing a lucerne grazing system on Bog Roy Station – A case study

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Abstract

This case study reports the impact on animal performance from changes in the feed supply on Bog Roy Station measured over 16 years. Since 2008, feed supply has been increased through expansion of the dryland lucerne area and use of legume dominant grass mixes under irrigation. In 2023, 154 t weaned lamb liveweight was produced from 4272 Merino ewes plus 9.0 t from hoggets. Mixed age ewes are now consistently 65.6±1.17 kg/hd at mating (2019–2023) and two-tooth weight at mating has increased 0.74±0.14 kg/hd/yr ($R^2 = 0.64$) from 52 kg/hd in 2012 to 61 kg/hd in 2023. Pregnancy scanning is now ~167±1.59% for the mixed age ewes (2012–2023) and has increased from 113% (2008) to 154% (2023) in the two-tooths. Lamb wastage (scanning to tailing) for the mixed age ewes has decreased 0.70±0.08%/yr ($R^2 = 0.88$) from 24% (2012) to 15% in 2023. The wastage in two-tooths has reduced from 32% (2014) to 21% (2023). Lamb wastage was negatively related to two-tooth weight at set-stocking, so feeding light young stock is a priority. Since 2016, pre-weaning lamb growth rates have averaged 286±4.39 g/hd/d and weaning now occurs at 79.3±2.56 days, or 40 days earlier than in 2008. The consistency in pre-weaning lamb growth rates has coincided with the development of 210 ha of pivot irrigation which now grow lucerne/grass mixes. The increased animal production has not affected wool production and cow numbers have increased to cope with surplus pasture on hills. The major change in farm income has resulted from the earlier sale of more and heavier prime lambs at a higher average price associated with the extra feed available to ewes during lactation, and weaned lambs. This unique long-term dataset of on-farm performance provides a commercial example of transformational change in the farm system driven by an increased area of lucerne grazed by ewes and lambs during lactation. Subsequent, irrigation development has been focused on growing young stock to prime weights which is now allowing a proportion of hoggets to be mated.

Keywords: alfalfa, *Medicago sativa*, lambing %, scanning %, StockCare

Introduction

‘Bog Roy’ is a high-country station in the Upper Waitaki region of the McKenzie District that receives about 420 mm of annual rainfall. The farm experiences a short spring growing season, due to 90–120 days of no winter growth, followed by low spring and summer rainfall and high evapotranspiration rates. In 2008 the farmers implemented a change to their feeding system and the impacts of that on animal and financial performance were previously documented (Anderson et al. 2014; Moot et al. 2019). Specifically, the area of lucerne and lucerne/grass mixes quadrupled from 60 to 265 ha. Consequently, the amount of supplementary feed made, and its associated costs were halved because ryecorn (*Secale cereale*), sown as part of the lucerne development, provides some of the winter feed, as does the lucerne winter clean-up graze. Over the first three years of lucerne expansion, total lamb liveweight weaned increased from 91 to 130 t, due to increased ewe performance (i.e. lambing % and lamb growth rate to weaning). In the second phase, 900 more ewes were added to the flock because of the extra feed grown. All ewes showed an increase in body condition score and were heavier at lambing, which resulted in higher pre-weaning lamb growth rates and lamb survival (Moot et al. 2019). By 2018 mixed age ewes were lambing 141% (to tailing) and pre-weaning Merino lamb growth rates exceeded 270 g/hd/d. This enabled weaning after 80 days and a 48% increase in the amount of lamb liveweight weaned per ewe mated from 25 to 37 kg.

In 2015 a water right was transferred away from the shores of Lake Benmore to an area that was previously growing ~2 t DM/ha/yr. The development of 210 ha of centre pivot irrigation was initially sown with 55 ha of red (*Trifolium pratense*) and white (*T. repens*) clovers and the balance in ryecorn. This further increased pre-weaning lamb growth rates to ~300 g/hd/d (Moot et al. 2019). The results of the first 10 years of the pasture development at Bog Roy were reported in 2019. Fortunately, continued record keeping of animal performance means the longer-term resilience and impact of the transformational change to the farming system, based on the change in feed

supply, can be further quantified. Thus, the aim of this paper is to update the results of animal and financial performance of Bog Roy Station since it changed its feed base in 2008. This includes farmers' reflections of the successes, and mistakes (learning opportunities) that these changes have created for their farm over time.

Materials and Methods

Property description and pasture development

The property was fully described previously (Anderson et al. 2014). Briefly, in 2008, the 2860 ha property had 60 ha of lucerne with half grazed and half conserved. About 100 ha of flood irrigated ryegrass (*Lolium perenne*) and tall fescue (*Schedonorus phoenix*) pastures were used each spring to finish overwintered lambs, and then closed for baleage. From 2008 to 2015, the dryland lucerne area was expanded by ~30 ha per year to reach 265 ha of lucerne and lucerne/ cocksfoot (*Dactylis glomerata*) mixes. In 2015, the flood irrigation on the edge of Lake Benmore ceased and the water right was transferred to the development of two centre pivots on an area of shallow stony soils that previously grew ~2 t DM/ha/yr. In 2016, 53.5 ha of red and white clover was established, with a further 155 ha in ryecorn (*Secale cereale*). In 2017 a further 53.5 ha ex ryecorn was put into red and white clover under one pivot. A further 65 ha of prairie grass (*Bromus willdenowii*) and lucerne was established and 38 ha was in turnips (*Brassica rapa* subsp. *rapa*) and annual ryegrass (*Lolium multiflorum*) for winter feed. In 2018, another 38 ha of the lucerne/ prairie grass mix was established. In winter of 2019, Porina spp. decimated all the permanent pasture areas. The lucerne was least affected and recovered while prairie grass and white clover re-established from hard seed in the soil seed bank. In spring 2019, 53.5 ha of the damaged pasture was sprayed with glyphosate (360 2L ai/ha) and then redrilled with lucerne, prairie grass and cocksfoot. The cocksfoot dominated the establishment and outcompeted the lucerne. Therefore, from 2020 onward the preferred mix drilled under the pivots has been 9 kg/ha of lucerne with 4 kg/ha of prairie grass, 1 kg/ha of timothy (*Phleum pratense*), 2 kg/ha of chicory (*Cichorium intybus*) and 1 kg/ha each of plantain (*Plantago lanceolata*) and white clover broadcast on the surface. The aim is for legume dominant pastures to drive liveweight gain (Moot et al. 2019) and allow early lamb weaning. Since 2019 the permanent pastures have not needed to be renewed, so it is the 10% of the pivot areas used for winter green-feed that drives pasture renewal. The flush of feed from the pivots in mid-spring exceeds animal demand, so 20-40 ha of silage is made in November, when dryland pastures are also growing at their fastest rate.

Dryland pasture development uses ryecorn for two years to break in low-production, poor-quality grass-

dominant pastures before direct drilling lucerne. Ewes are now routinely lambled on some of the dryland lucerne area, stocked at 7-8 ewes/ha for ~4 weeks and then mobbed into groups of 500-750 ewes+lambs for rotational grazing on the dryland lucerne. These lucerne stands have been productive for ~12 years. Once the dryland plant population has declined to a point where weeds are dominant stands are renewed. These stands are sown in ryecorn for two years before being direct drill back into lucerne at 11 kg/ha with cocksfoot at 2 kg/ha. The addition of the grass has reduced the need for winter sprays and the invasion of horehound (*Marrubium vulgare*). However, grazing management focuses on the lucerne.

Animal performance data

Until 2015 all 3500 ewes were mated to the Merino ram but in 2016 a change in policy was made to take advantage of the increasing lambing percentage and higher lamb growth rate. Romney rams were mated with non-replacement ewes (25% of the ewes) in 2016. Because finishing lambs compromised replacement ewe lamb growth rates, and ewe performance, >50% of all sale Merino lambs were being sold store at weaning up to 2015. This changed in the 2015/16 season when all lambs were able to be retained to consume the extra feed being grown. Even though 70% of these were sold prime, >60% did not go until October. The introduction of a Romney ram as a terminal sire and continuing improved feed quality meant all sale lambs (Halfbred as well as Merino), with the exception of cull Merino ewe lambs and a few carry-over retained sale lambs, are now off the property as shorn prime lambs by the end of May. For each sale mob, lamb/hogget performance data are quantified by recording date of sale, numbers sold, average body weight (kg/hd), average value (\$), liveweight value (c/kg) and for processed lambs average carcass weight.

Ewe management involves start of mating on the 23rd April with ram removal 35 days (2 cycles) later, scanning 22nd July with lambing starting on the 20th September. Weaning for ewes begins on the 14th December and finishes with hogget weaning on the 12th January.

The key flock performance and financial changes have continued to be documented since 2012 using the flock recording programme StockCARE (<https://stockcare.co.nz/>). The lamb wastage for ewes and hoggets is calculated as:

$$\text{Lamb wastage (\%)} = (\text{number of lambs scanned} - \text{number of lambs tailed}) / \text{number of lambs scanned} \times 100$$

Ewe flock performance, on an annual basis, is quantified as the weight (kg) of lamb weaned per ewe

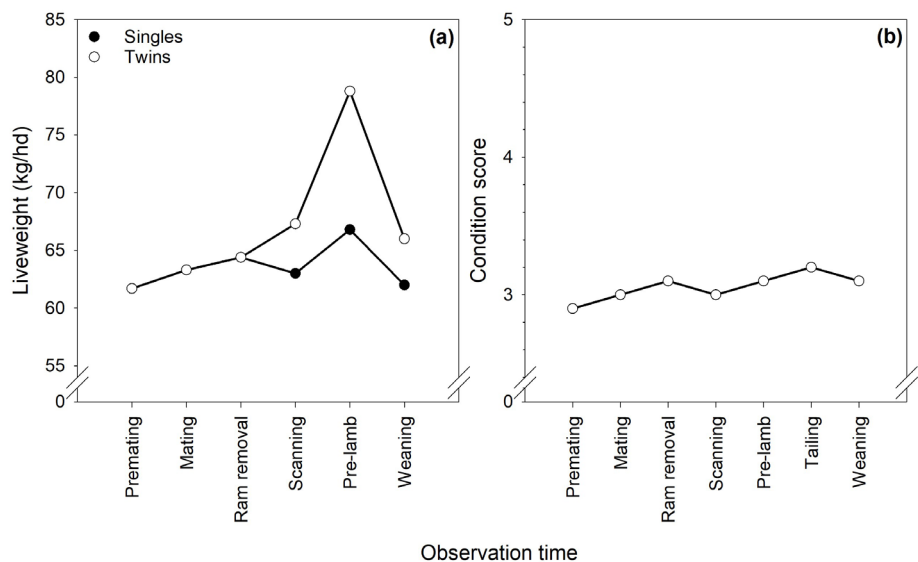


Figure 1 (a) Liveweight (kg/hd) and (b) condition score (1-5) of single (●) and twin bearing (○) mixed age ewes from pre-mating

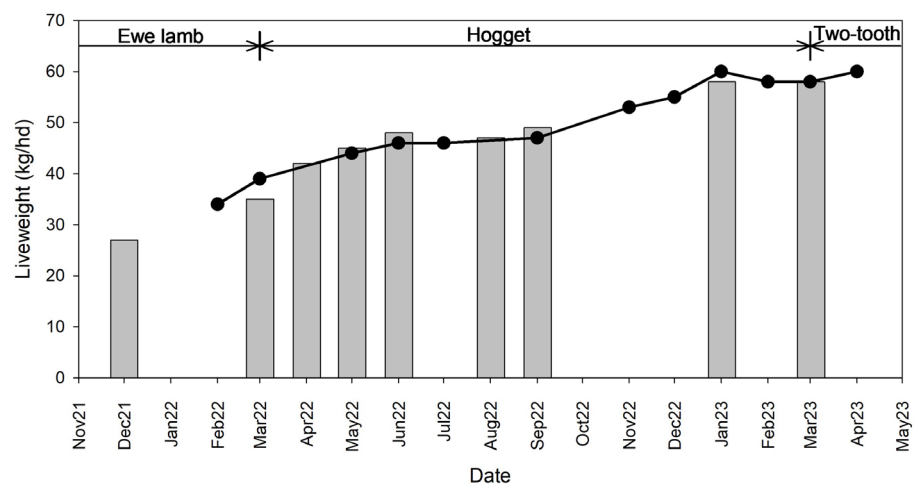


Figure 2 Mean liveweight (kg/hd) of ewe lamb replacements vs. target weight (●) between December 2021 and March 2023 at Bog Roy Station. Horizontal lines show when stock class changes occur over time.

mated. This requires accurate tallies of the number of lambs weaned and their weaning weights, as the ultimate measure of lambing percentage, and lamb growth rate to weaning. The ewe flock performance is therefore driven by their management, which is monitored throughout the year by weighing and body condition scoring a minimum of 50 randomly selected ewes per mob at set times. This enables the impact of ewe feeding to be quantified. Liveweight (kg/hd) and body condition score (1-5) are taken at weaning, one month pre-mating, mating, ram removal, pregnancy scanning, and at set stocking prior to lambing, as

outlined for 2023 in Figure 1. Lambing mobs are also condition scored at tailing/docking time. The condition scoring over 15 years has been undertaken by several different people, so measured weights are reported to avoid any potential operator bias. Hoggets are also regularly monitored to track liveweight gains and to modify management to ensure they reach their target liveweights, which are set in advance (Figure 2). Important targets include reaching an average of 45 kg/hd at mating, with all hoggets ≥ 42 kg/hd mated. The next target is for them to reach 60 kg/hd by mating as a two-tooth.

Basic cattle data were available prior to development, but more detailed cattle performance recording began in 2018. All mixed age Hereford cows are mated to a Simmental bull and, annually, an additional 20-25 in calf R2 heifers are brought in.

Statistical analysis

Data averaged over time are reported with their relevant standard error of the mean (Mean $\pm$ SEM). Linear regressions were fitted in Genstat (v22, Lawes Agricultural Trust). Regression parameters are reported with their respective standard errors ($\pm$ SE) and coefficient of determination (R^2).

Results & Discussion

In 2008, the 3532 mixed age ewes wintered produced 90.8 t of weaned lamb (Figure 3). By 2018, the 4411 ewes mated produced 159 t weaned lamb. The number of ewes peaked at 4530 in 2019 but has since reduced to 4272 in 2023 because hogget lambing has become routine, and cattle numbers have increased. In 2023, a total of 163 t lamb liveweight was produced, with 9.0 t produced by the hoggets. In 2021 no hoggets were mated because of footrot and the sale of a block of 35 ha of dryland lucerne near Lake Benmore.

The initial improvements in flock performance (2009–2015) occurred when the emphasis was on dryland pasture development. The 2016–2018 period reflects the transfer of the water right to the centre pivot irrigation development and from 2019 onwards the pastures under the pivot were in full production.

Lambing percentage and lamb growth rates

In 2008 the mixed age ewes averaged 107% lambing to tailing (Figure 4). This has steadily increased by $2.36\pm0.26\%/yr$ ($R^2 = 0.88$) to be 144% in 2022 and 2023. At the same time the two-tooth lambing percentage has increased at a faster rate ($2.60\pm0.48\%/yr$; $R^2 = 0.72$) from 84 to 123%. Thus, the increase in mixed age ewe performance (lambing % and lamb growth rates to weaning) has not been at the expense of the younger class of stock. The overall increase in performance resulted from more, and higher quality, feed being available. The lambing percentage of the two-tooth flock has been more variable, with a drop in 2018 from missing ewes, due to a rustled mob of two-tooths, and footrot in 2019. Footrot negatively affected mating weight, pre-lamb weight and condition score measurements and resulted in poorer scanning and greater lamb loss.

The mean pre-weaning lamb growth rate was 178 g/hd/d in 2008 and peaked at 295 ± 1.15 g/hd/d from 2016 to 2018 (Figure 5). With these increased lamb growth rates, and the high-quality legume dominant feed available, all lambs are now able to be weaned at

an average of 25 kg/hd at 79 ± 2.74 days (2017–2023), compared with the 116 days in 2018, with no check in their growth rate. Reducing the ewe competition means all lambs can be retained under the pivots and the dryland lucerne. This reflects the value of the dryland lucerne and pivots in the system.

The early weaning is possible because of the higher quality feed available for lambs post-weaning. However, the higher pre-weaning lamb growth rates with early weaning (Figure 6) is expected because lambs grow fastest in early to mid-lactation.

After weaning, lambs are returned to the paddock they were grazing while the ewes are moved to the hill country. The pastures under the pivots are then grazed by weaned lambs from December until they leave the property. Lambs that were on dryland lucerne from birth continue to graze lucerne until feed supply drops and then they are moved to the irrigated pastures. Post-weaning growth rates have been recorded since 2012/13 (Figure 7). Growth rates initially increased from 35 (2012/13) to 99 g/hd/d (2017/18) and then stabilised from 2017/18 to 2022/23 at 94 ± 3.5 g/hd/d. Over this same six-year period the average days to sale was 149 ± 8.8 d. Livestock sales commence with the terminal lambs and annual draft ewes in mid-January, followed by surplus Merinos (retained sale lambs) from the end of March until the end of May. In addition, 800–1000 predominantly ewe lamb replacements are carried over winter.

Mating weights

The impact of the improved feed supply (Anderson et al. 2014) has meant ~60% of hoggets now reach their target weights of 45 kg in May for mating. Based on this an initial hogget mating was trialled on the 17th May 2019 with 34% (339) of the hoggets. They were 49 kg/hd at mating and tailed 42%. Since then, regular hogget mating has occurred, except for 2021 (due to footrot), with an average of $61\pm2.7\%$ (680 ± 22.2) of the hoggets mated at 46.7 ± 0.88 kg and tailing $52\pm3.3\%$. The aim is then for hoggets to reach their two-tooth target mating weight of 60 kg.

Preferential feeding of lighter ewes post-weaning aims to regain a minimum condition score of 3.0 by mating. This is associated with an increase in overall flock body weight (Figure 8). Since recording began in 2012 the mating weight of mixed age ewes has increased $\sim0.75\pm0.24$ kg/hd/yr, from 59 to ~67 kg/hd. The variability in ewe mating weight ($R^2 = 0.44$) reflects the growth on the hills, which is affected by in season rainfall. In 2023 it dropped to 63 kg/hd due to a drop in feed quality from 200 mm of spring rainfall. This meant there was a surplus of feed but a reduction in quality.

The increase in two-tooth mating weight has been

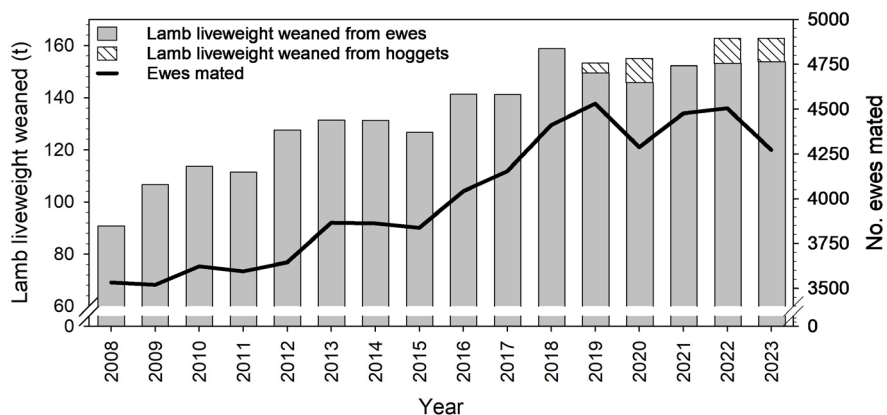


Figure 3 Lamb liveweight weaned (t/yr) from ewes or hoggets and the number of ewes mated at Bog Roy Station in the Mackenzie District from 2008 (pre-development) to 2023.

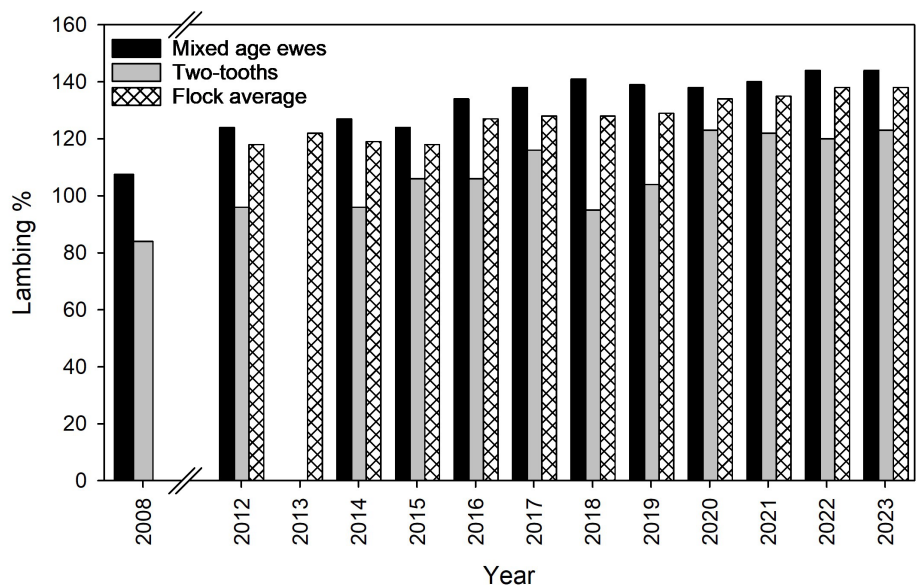


Figure 4 Lambing percentage (%) of mixed age ewes, (2008; $y = 2.36(\pm 0.258)x$; $R^2 = 0.88$), two-tooths (2008; $y = 2.60(\pm 0.479)x$; $R^2 = 0.72$) and averaged over the whole flock (2012; $y = 1.97(\pm 0.19)x$; $R^2 = 0.91$) at Bog Roy Station from 2008 to 2023.

more consistent ($R^2 = 0.64$), at the same rate (0.74 ± 0.14 kg/hd/yr) but started at 45 kg in 2008 before the dryland development. The increased lucerne area was prioritised for two-tooth feeding during summer which was reflected in increased two-tooth mating weights. They now average 60 kg/hd when mated, which means they are above the recommended mating weight to maximise fertility of at least 65% of their mature weight (Kenyon et al. 2014). The drop in mating weight of both classes of stock in 2015 coincided with a dry year, exaggerated by the removal of the irrigation water near Lake Benmore before the pivot development was completed.

Lamb wastage and pre-lambing weights

This increased weight of the mixed age ewes has also been reflected in a steady ($R^2 = 0.88$) $0.70 \pm 0.08\%/yr$ reduction in their lamb wastage (scanning to tailing) from 24 to 15% (Figure 9). This is associated with preferential feeding of twin bearing ewes, scanning into lambing dates and subdivision of paddocks which includes identifying (through recording ewe tallies per paddock at set stocking and ewe and lamb tallies at tailing) those with high and low survival outcomes. The higher lambing percentages have also enabled a stricter culling policy for all dry/dry and wet/dry ewes,

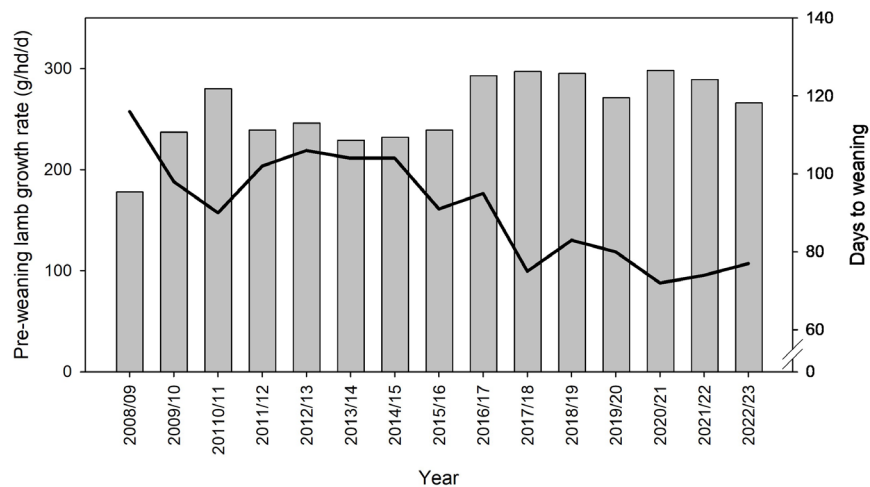


Figure 5 Pre-weaning lamb growth rates (g/hd/d; bars) and time to weaning (days; line) from 2008 (pre-development) to 2023 at Bog Roy Station.

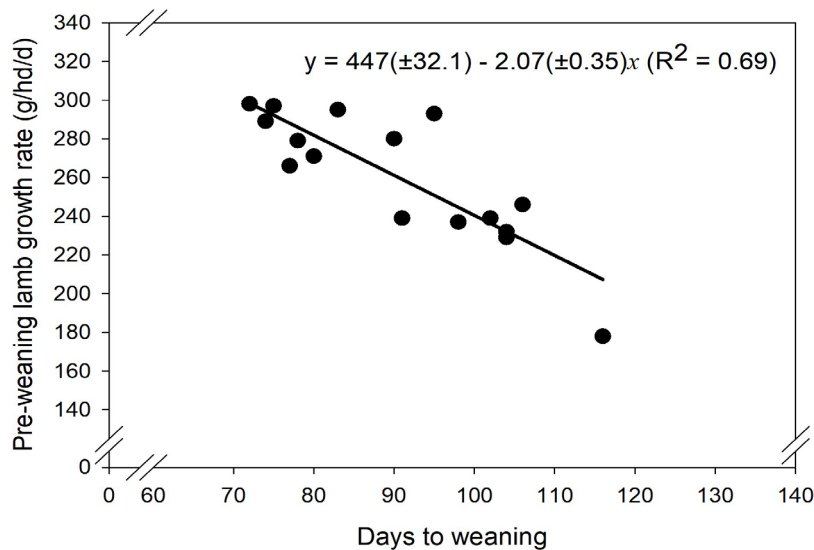


Figure 6 Pre-weaning lamb growth rate (g/hd/d) against days to weaning of Merino lambs at Bog Roy Station (2008-2023).

and those with defective udders. Continued vaccination for Johnes disease is known to reduce ewe loss and, consequently, lamb loss (Gautam et al. 2018).

For the two-tooths, the rate of reduction in lamb wastage (Figure 9) has reduced at the same rate as for the mixed age ewes but with greater annual variation ($R^2 = 0.13$). In three years since 2012, two-tooth wastage exceeded 30%, due to rustling losses in 2018 and footrot in 2019, but since 2019 it has averaged $20.8 \pm 1.03\%$. Two-tooths are now lambed on blocks with higher survival rates and an increasing proportion are experienced mothers having lambed as hoggets.

The weight and body condition of ewes at the end of winter contributes positively to lamb birth weight, udder development, ewe colostrum and milk production and, thus, pre-weaning lamb survival and growth (Kenyon & Webby 2007). The mixed age ewe weights have only been recorded since 2013 but show a consistent weight of 62.5 ± 1.39 kg/hd for the singles and 68.9 ± 1.56 kg/hd for the twins (Figure 10). Twins are preferentially fed on a rape/annual ryegrass mix or dryland ryecorn from beginning of August (post-shearing) to set stocking in mid-September. Silage and barley grain are also fed as supplements during this period. These combined

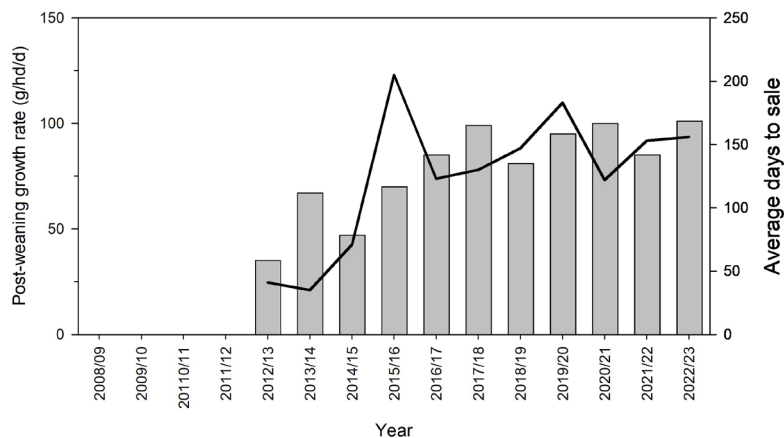


Figure 7 Post-weaning lamb growth rates (g/hd/d; bars) and average days to sale (d; line) from 2012/13 to 2022/23 at Bog Roy Station.

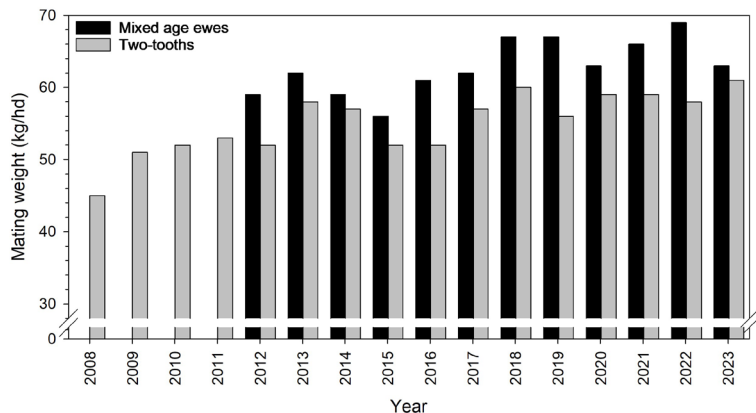


Figure 8 Mating weights (kg) of mixed age ewes (2012; $y = 0.75(\pm 0.24)x$; $R^2=0.44$) and two-tooths (2008; $y = 0.74(\pm 0.14)x$; $R^2=0.64$) from 2008 (pre-development) to 2023 at Bog Roy Station.

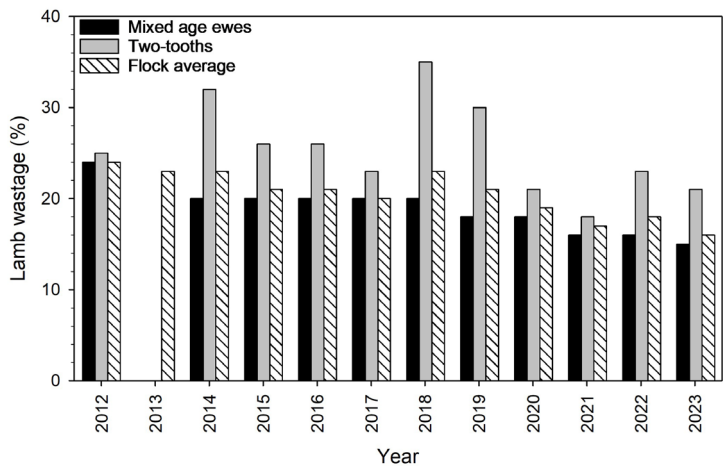


Figure 9 Lamb wastage (%) of mixed age ewes (2012; $y = 0.70(\pm 0.080)x$; $R^2=0.88$) and two-tooths (2012; $y = 0.68(\pm 0.435)x$; $R^2=0.13$) at Bog Roy Station from 2012 to 2023. The regression fitted to the whole flock average from 2012 had the form $y = 0.64(\pm 0.103)x$ ($R^2= 0.77$).

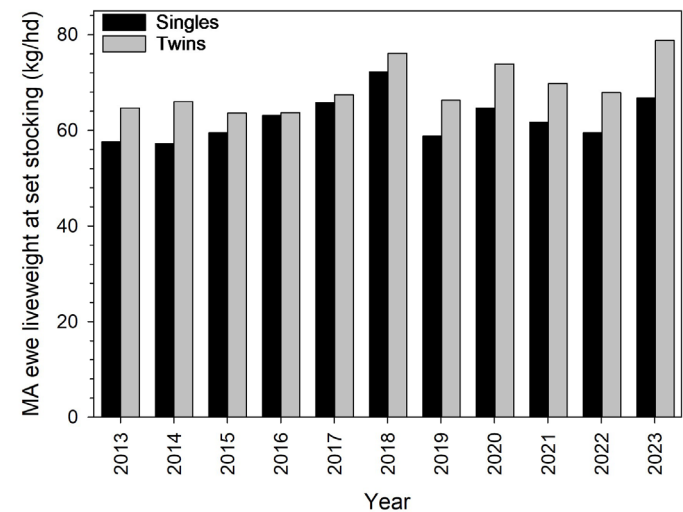


Figure 10 Pre-lambing liveweights (kg) of mixed age (MA) ewes bearing either singles or twins at Bog Roy Station from 2013 to 2023.

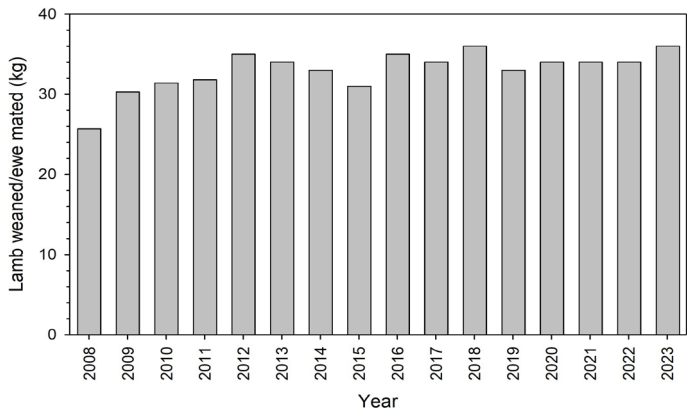


Figure 11 Lamb liveweight (kg) weaned per ewe mated from 2008 (pre-development) to 2023 at Bog Roy Station.

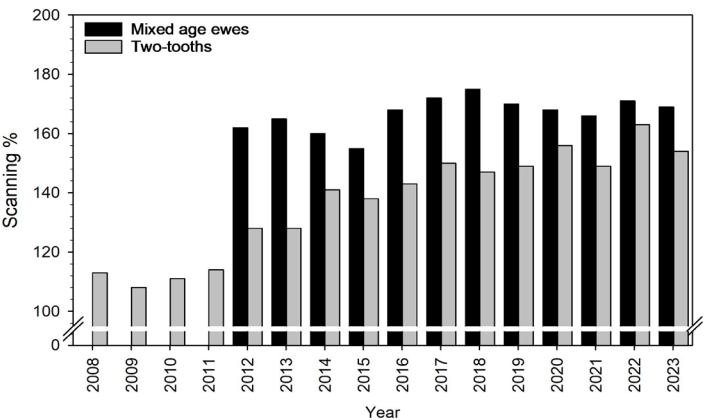


Figure 12 Pregnancy scanning percentage (%) of mixed-age ewes from 2008 (pre-development), and two-tooths from 2012, to 2023 at Bog Roy Station.

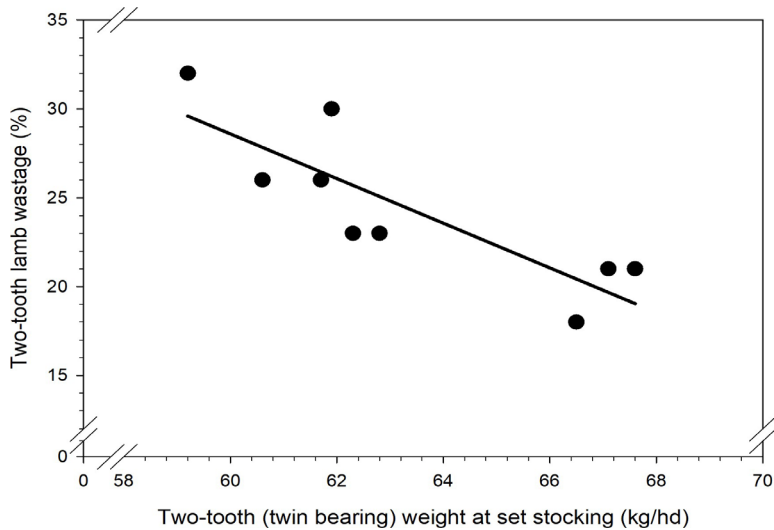


Figure 13 Two-tooth lamb wastage (%) against the liveweight of twin bearing two-tooths at the start of set stocking prior to lambing. Form of the linear regression is $y = 77.13(\pm 3.38) - 0.57(\pm 0.136)x$ ($R^2 = 0.67$).

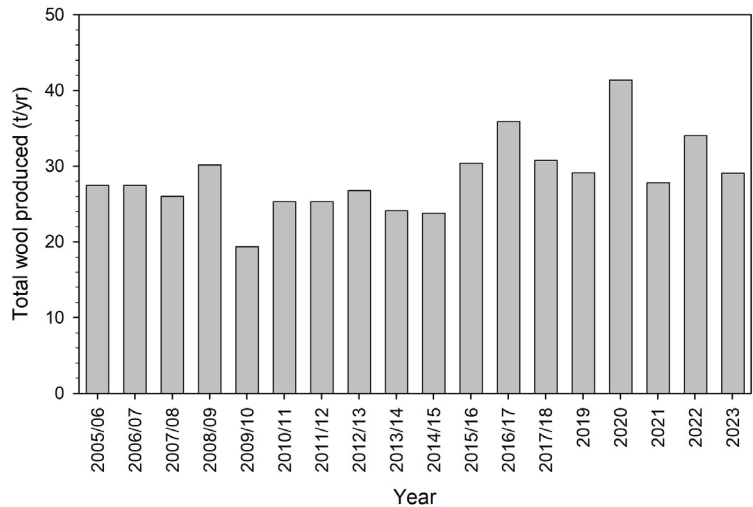


Figure 14 Wool production from ewes and hoggets (t/yr) at Bog Roy Station from 2005 to 2023. Data prior to 2008 is from the pre-development period.

changes have increased liveweight production to an average of 34.2 ± 0.63 kg lamb weaned/ewe mated from 2019-2023 (Figure 11).

Preferential feeding of replacement ewe lambs has been a major contributor to the increased reproductive performance of the total flock. Regular weighing of ewe hoggets occurs from weaning to mating as a two-tooth and feed is allocated to ensure they reach their target weights (Figures 2 & 8). This is reflected in their pregnancy scanning performance which has increased 3.55% per annum from 113% in 2008 to an average of $156 \pm 2.90\%$ in the last four years (2020-2023; Figure 12), and consequently lifted their lambing from 84% to

$122 \pm 0.71\%$ (Figure 4). The importance of ewe weight at set stocking on lamb survival is illustrated in (Figure 13).

Wool production

Despite the emphasis on weaned lamb production, the wool is 18 micron and has remained relatively stable at $\sim 32,000$ kg/yr over the past five years (Figure 14). The annual variation in total wool production reflects the earlier selling of some stock, particularly the hoggets and terminal sire lambs, which are now sold at a younger age with some unshorn.

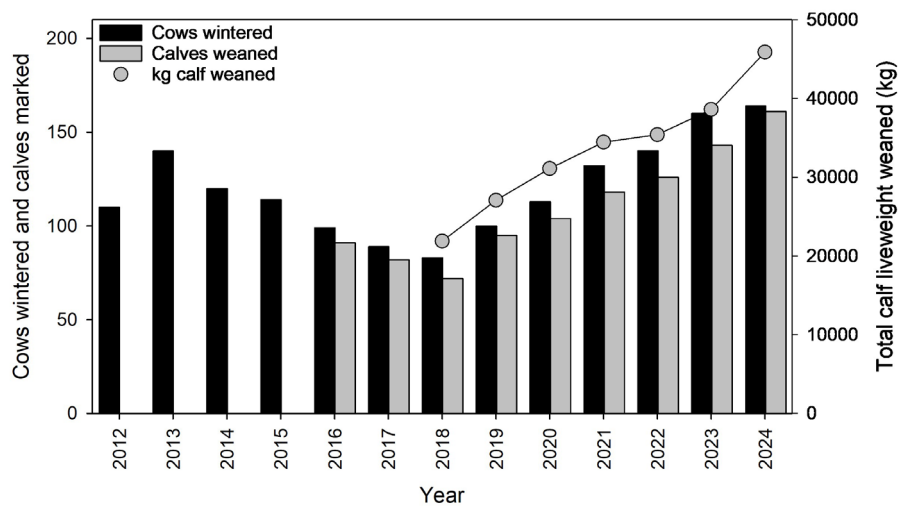


Figure 15 Number of calves weaned (■) from cows wintered (■), and total calf liveweight weaned (●) at Bog Roy Station between 2012 and 2023.

Cattle production

Cow numbers initially dropped during the dryland development period (Figure 15). This was because the cattle were used to buffer changes in feed supply across the farm system as the dryland area and irrigation were developed. Cattle numbers were lowest when the total feed supply was reduced in 2015-2017, through a dry period when tenure review returned a flat area of 120 ha near the Otamatapaio River to the Crown. Cow numbers remained low as the pivot development was prioritised, but these have subsequently steadily increased to be higher than they were pre-development.

Since recording of cattle data in 2018, the Hereford cow herd pregnancy rate has averaged 94±2.3% with calves weaning at an average of 289±7.2 kg/hd. The

cows have weaned an average of 266±6.2 kg calf liveweight/pregnant cow wintered. In 2024 there are currently 186 in calf cows being wintered with the plan to eventually winter 200. Over the period 2018 to 2023 the weight of calves sold has increased from 22T to 46T which at \$3/kg equated to an additional \$72,000 of income.

Financially, the total revenue from lamb sales, excluding income from wool from shorn lambs or hoggets, has been recorded since 2012. This has trebled from \$236,000 in 2012 to over \$715,000 (Table 1). The additional value per lamb is in part due to their heavier weights which means more lambs are sold prime, and Halfbred and Merino ewe lambs are sold at higher prices to other farmers as replacements.

Table 1 Liveweight of lambs sold at and post weaning, total lamb income and average price per kilo between 2012/13 and 2022/23 at Bog Rog Station.

Year	Pre weaning lamb sales (kg)	Post weaning lamb sales (kg)	Total lamb income (\$)	Average LWt value (c/kg)
2012/13	59,500	41,300	236,409	234
2013/14	56,800	42,800	238,503	239
2014/15	53,704	55,896	256,911	234
2015/16	0	133,800	337,499	252
2016/17	14,700	132,300	436,956	297
2017/18	0	167,688	623,074	405
2018/19	13,965	156,779	594,497	348
2019/20	19,080	172,978	596,272	310
2020/21	0	180,740	596,701	330
2021/22	0	179,521	743,364	414
2022/23	16,820	197,089	714,999	334

Conclusions

The dryland pasture management changes implemented at Bog Roy Station required the farmers to learn new skills, engage with rural professionals and accept change was necessary to increase production on their farm. The initial changes appear simple in hindsight, but the confidence to change the whole farm system to target legume management was new. The ability to record and document changes in stock performance over time has been invaluable to give the farmers confidence to trust in the process. Since 2008 an additional 70 t liveweight of weaned lamb annually and since 2018 an additional 24 t of weaned calf have resulted in a more resilient farm system that provides opportunities for the future that were not possible a decade ago.

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