New Zealand Journal of Agricultural Research

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/tnza20

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To cite this article: Lydia J. Farrell, Stephen T. Morris, Paul R. Kenyon & Peter R. Tozer (05 Feb 2024): A bio-economic modelling comparison of a Friesian Bull-Beef system and a New Generation Beef system with Friesian bulls slaughtered at 10–14 months old, New Zealand Journal of Agricultural Research, DOI: 10.1080/00288233.2023.2297834

To link to this article: https://doi.org/10.1080/00288233.2023.2297834

NEW ZEALAND JOURNAL OF AGRICULTURAL RESEARCH
https://doi.org/10.1080/00288233.2023.2297834

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A bio-economic modelling comparison of a Friesian Bull-Beef system and a New Generation Beef system with Friesian bulls slaughtered at 10–14 months old

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ABSTRACT
Finishing of dairy-origin calves in an accelerated 'New generation beef' (NGB) beef finishing system for slaughter up to 14 months of age has potential co-sector benefits. These include production efficiencies and a reduced number of dairy calves slaughtered at a very young age. In the present study, a NGB system and an 18-month Bull-Beef system were first modelled separately, both purchasing three-month-old Friesian bull calves. Then Mixed systems with varying proportions of both NGB and Bull-Beef animals were modelled. Production, feed balance and profitability were compared, using cash operating surplus (COS) as a profit indicator. In the NGB scenario, double the number of animals were finished compared with the Bull-Beef scenario; however, monthly feed demand was less synchronous with predicted pasture supply, requiring more feed transfer via pasture baleage. The COS for the NGB system was $−571/ha, with less income and greater costs than the Bull-Beef system (COS = $2026/ha). Break-even prices for NGB animals were up to 74% above current prices, but break-even prices were less in Mixed systems with a greater proportion of Bull-Beef animals. Without high price premiums, challenges remain for the NGB systems appeal to beef finishers due to their low slaughter weights and sale prices.

ARTICLE HISTORY
Received 18 October 2023
Accepted 13 December 2023

KEYWORDS
Bobby calves; efficiency; veal; accelerated finishing; profit

Introduction

The New Zealand dairy farming sector produces surplus calves to what is needed for herd replacement, and the slaughter of some of these calves at less than two weeks of age ('bobby calves') has possible negative impacts for consumer perceptions concerning the ethics of dairy production (Edwards et al. 2021). An estimated 74% of New Zealand's beef production is currently from animals originating in the dairy industry, including approximately 0.85 million cull cows, 1.89 million bobby calves and 0.70 million calves entering the beef finishing sector (BLNZ Economic Service 2022). There are established options for the incorporation of dairy-origin animals into the New Zealand beef

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sector. These include bought-in replacements for a breeding herd of beef-dairy cross-breed cows (Farrell et al. 2022), once-bred heifers (dairy-origin heifers bred to beef sires and then sold before three years of age), steer finishing and Friesian Bull-Beef finishing (Morris 2019). In Friesian Bull-Beef systems three-month-old male calves are purchased by beef farmers from a calf-rearing enterprise and grown out to an approximately 300 kg carcass weight, ideally before reaching two years of age, i.e. before their second winter (Coleman et al. 2016; Morris and Hickson 2016). The meat produced from Friesian Bull-Beef systems is mainly destined for the processing and ingredient beef markets, with relatively lower prices per kg than prime beef (BLNZ 2017).

In New Zealand, an accelerated system for finishing calves of dairy-origin termed New Generation Beef (NGB) has recently been explored, where three-month-old dairy-origin calves are purchased by beef farmers from a calf-rearing enterprise and the calves are grown for slaughter at up to 14 months of age, at around 300 kg liveweight (Pettigrew et al. 2017; Addisu et al. 2021). Therefore, in the NGB systems, there is the potential to manage more calves per ha than in a Friesian Bull-Beef system, for greater reductions in bobby calf numbers. Pike et al. (2019) identified meat from NGB animals to be of high eating quality. However, currently the per kg carcass value for NGB animals is at best the equivalent of the manufacturing beef price, as they have little fat cover. There is potential for this value to be reduced further, on a per kg basis, due to the light overall carcass weight (Addisu et al. 2023; Interest 2023).

Addisu et al. (2023) noted that the animal best suited for NGB is a bull calf with relatively higher growth than heifers or steers. These NGB bull calves need to be well fed if they are to reach target slaughter weights at a young age and thus would likely compete with Friesian Bull-Beef systems for land (Addisu et al. 2021). The profitability of NGB systems, with animals sold at lighter liveweights for lower prices, has not compared favourably with Friesian Bull-Beef systems (Hunt et al. 2019; Addisu et al. 2021, 2023). This reduces the uptake of the NGB system by beef farmers and the development of a value chain for NGB in the meat sector, limiting the potential use of this system to utilise surplus dairy-origin calves. However, to date it has not been determined what per kg carcass price for NGB beef is needed to be competitive with beef from an 18-month Friesian Bull-Beef system.

Therefore, the first objective of the current study was to adapt an existing bio-economic beef model (Farrell et al. 2021) to compare the productivity, monthly feed balance and profitability of Friesian Bull-Beef and NGB systems. It was hypothesised that the profitability of a NGB system would be less than that of a Friesian Bull-Beef system. The second objective was to determine the potential profitability of a mixed NGB and Bull-Beef system. The third objective was to determine the break-even price for carcass value of NGB animals where the enterprise profitability would match that of an 18-month Friesian Bull-Beef system.

Methods

A bio-economic simulation approach was used, utilising a sheep and beef farm model developed in STELLA Architect v1.8 (isee systems 2023) and previously used to investigate New Zealand pasture-based beef farm systems (Farrell et al. 2021, 2022). The existing model already included the liveweight gain, feed demand, costs and income from youngstock destined for sale, represented as ‘stocks’ with ‘flows’ between months spent on-farm. Thus, the feed demand, feed supply and economic modules from the established model were used. The model was updated to expand the beef trading stock module by adding the ability to purchase calves for finishing and adding more classes of traded stock so that multiple liveweight gain profiles were represented. More detail of the base model workings is given in Farrell et al. (2021). The Friesian Bull-Beef system was modelled first and acted as a benchmark scenario, used to confirm the annual feed supply from pasture and subsequent stocking rate. The Bull-Beef Benchmark scenario was also used to set profitability targets and determine the break-even sales price needed for NGB systems. The current study modelled only the beef enterprise and not the on-farm sheep enterprise as per previous beef models (Farrell et al. 2021, 2022). Adjustments were made to the feed supply and economic estimates to account for the feed consumed by and expenses attributable to the sheep enterprise.

Farm system and production

The farm was assumed to be on 208 ha flat and rolling drystock land in the Manawatu region of New Zealand, a farm categorised as Class 5 North Island finishing with high quality pasture and a high proportion of stock sold direct to slaughter (BLNZ Economic Service 2023a). The feed supply on-farm was assumed to be mostly from grazed pasture as is typically practiced in New Zealand sheep and beef systems (Nicol and Brookes 2007) and published data which informed animal performance was from those consuming grazed pasture. It was assumed the beef enterprise had only trading stock, i.e. without a breeding beef-cow herd and purchasing weaned calves of at least three months of age, where beef cattle consumed 46% of total feed on-farm for all modelled scenarios, with the remainder consumed by sheep (BLNZ Economic Service 2023b).

For simulation of both the Bull-Beef (Benchmark) and NGB systems, calves were assumed to be Friesian bull calves purchased from a rearing enterprise and brought on-farm at three months of age in November with an average liveweight of 100 kg (Pettigrew et al. 2017). To simulate variation in growth rates between calves for both the Bull-Beef and NGB systems, calves were divided into three cohorts with roughly a third of calves in each. It was assumed liveweight and growth rates of the animals had a coefficient of variation of 20% (Muir et al. 2000; Pettigrew et al. 2017) and that they followed a normal distribution. The three cohorts contained 32%, 36% and 32% of purchased calves and had average liveweights of 80, 100 and 120 kg, respectively. The calves were assumed to have varied in their growth rates since birth (prior to being brought into the finishing system) and thus the cohorts with calves weighing 80, 100 and 120 kg at purchase are referred to as the 'slow', 'medium' and 'fast'-growing calves, respectively, with matching growth rates as detailed in Table 1. Growth rate values assumed in the current study were informed by studies of Friesian bull calves younger than 14 months (Pettigrew et al. 2017; Hunt 2019) and Friesian bulls up to two years of age (McRae 1988; Journeaux et al. 1987; Coutinho et al. 1998; Litherland et al. 2002; Cosgrove et al. 2003). In the Bull-Beef Benchmark scenario, the medium and fast-growing animals were slaughtered at 300 kg average carcass weights, with timings outlined in Figure 1. The slow growing animals were slaughtered with an average carcass weight of 270 kg before their second winter. Animals in the modelled Benchmark Bull-Beef scenario remained on-farm until 16–21 months of age and there was overlap between calves

Table 1. Purchase weights (kg) and seasonal growth rates (kg/day)[a] of cohorts of fast, medium and slow-growing calves.

		Growth rate from three to 12 months of age[b]				Growth rate from 12 to 21 months of age[c]		
Cohort	Purchase weight (kg)	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn
Fast	120	0.96	0.88	1.03	1.13	1.56	1.44	1.20
Medium	100	0.80	0.73	0.86	0.94	1.30	1.20	1.00
Slow	80	0.64	0.59	0.69	0.75	1.04	0.96	0.80

[a]Growth rates from McRae (1988), Journeaux et al. (1987), Coutinho et al. (1998), Litherland et al. (2002), Cosgrove et al. (2003), Pettigrew et al. (2017) and Hunt (2019).
[b]Growth rates apply to animals in all modelled scenarios during their first year of life, starting when purchased at three months of age in spring (November).
[c]Growth rates apply to animals in all modelled scenarios during their second year of life.

purchased each November, i.e. in November each year there were newly purchased three-month-old calves on-farm as well as 15-month-old bulls purchased the previous year. In the NGB scenario, the medium and fast-growing NGB animals were slaughtered at 306 kg average liveweight (approximately 147 kg carcass weight), while the slow growing NGB animals were slaughtered at 332 kg average liveweight (approximately 166 kg carcass weight) just before the next year's calves were purchased.

For productivity and efficiency comparisons, liveweight gain and net carcass weight sold were calculated for each modelled scenario on a per hectare basis. Liveweight gain was estimated from the difference between sale and purchase liveweights

		Bull-Beef			New Generation Beef		
Age (months)	Month (calendar)	Fast	Medium	Slow	Fast	Medium	Slow
3	November	Purchase	Purchase	Purchase	Purchase	Purchase	Purchase
4	December						
5	January						
6	February						
7	March						
8	April						
9	May						
10	June				Slaughter		
11	July					Slaughter	
12	August						
13	September						
14	October						Slaughter
15	November						
16	December	Slaughter					
17	January						
18	February		Slaughter				
19	March						
20	April						
21	May			Slaughter			

Figure 1. Age and time of year for purchase and slaughter of various cohorts of fast, medium and slow-growing calves in Friesian Bull-Beef and New Generation Beef systems*. * Shading indicates the time when animals are on-farm between purchases from a rearing enterprise and sale for slaughter, e.g. slow-growing Bull-Beef animals are on farm for 19 months, between purchase at three months of age and slaughter at 21 months of age.

Table 2. Details[a] on sales of animals from Friesian Bull-Beef and New Generation Beef (NGB) finishing systems, each with slow, medium and fast-growing cohorts with all animals purchased in November.

System	Cohort	Sale timing	Sale LW (kg)	Sale price ($/kg CW)	Carcass dressing (%)	Carcass weight (kg)	Sale Price ($/head)
Bull-Beef	Fast	December	556	6.05	54.0	300	1815
	Medium	February	500	5.90	54.0	270	1770
	Slow	May	500	5.85	54.0	270	1580
NGB	Fast	June	306	4.13	47.5	145	600
	Medium	July	306	4.46	48.5	148	662
	Slow	October	370	4.89	50.0	166	904

[a]Growth rates and carcass dressing rates from McRae (1988), Beauchemin et al. (1990), Journeaux et al. (1987), Coutinho et al. (1998), Litherland et al. (2002), Cosgrove et al. (2003), Purchas et al. (2012), Pettigrew et al. (2017) and Hunt (2019).

(Tables 1 and 2). Net carcass weight sold was estimated as the difference between sale carcass weight (Table 2) and combining purchase liveweight with an assumed carcass dressing rate of 55% for three-month old calves (Beauchemin et al. 1990).

Feed demand and supply

Feed demand for modelled beef animals was estimated on a monthly basis in megajoules of metabolisable energy (MJ ME) based off liveweights and growth data from Table 1 and equations from Nicol and Brookes (2007) and Primary Industries Standing Committee (2007), as was done by Farrell et al. (2021, 2022). Feed demand for maintenance (ME_M) was estimated using:

$$ME_M = \left[0.392 \times \frac{LW^{0.75} \times e^{-0.03 \times a}}{0.02 \times P + 0.5}\right] \times 1.1$$

From Primary Industries Standing Committee (2007), where LW is liveweight in kg, a is age in years and P is pasture quality in MJ ME/kg DM (DM = dry matter). Feed demand for liveweight gain was assumed to be 35 MJ ME per kg (Nicol and Brookes 2007).

Feed supply was simulated monthly in MJ ME, based on long-term pasture growth rates from the district of Marton in the Manawatu Region of New Zealand (Trafford and Trafford 2011) and North Island sheep and beef farm pasture quality data which varied from month to month from Burggraaf et al. (2018). Monthly feed supply from pasture was then multiplied by 0.46 to represent the proportion of feed consumed by the beef enterprise, with the remainder consumed by the on-farm sheep enterprise (BLNZ 2023b). Total annual feed supply from pasture consumed by the beef enterprise was estimated to be 7.1 million MJ ME (approximately 647 t of DM total or 6.8 t DM/ha), and all beef system scenarios were modelled with feed demand to match, which determined animal numbers.

Bull-Beef and NGB animals were expected to differ in their monthly feed demand due to differences in sale timings, liveweights and ages while on-farm. Monthly feed balance was estimated as the difference between feed demand from the beef enterprise and feed supply from pasture grown. The modelled farm was assumed to be on highly productive land of flat to easy rolling contour (BLNZ Economic Service 2023a) where pasture conservation is practically feasible. The majority of monthly variations in feed balance were assumed to be mitigated through management of pasture covers. Where there was a monthly feed surplus of more than 39 t DM, the threshold set according to the Bull-

Beef (0% NGB) scenario used as a benchmark in this analysis, the surplus was assumed to be harvested for baleage to be fed within the beef enterprise during times of feed deficits.

Economics

Sale timing and carcass weight class for each cohort of animals within the two systems determined the sale price received on a per kg carcass basis. For the Bull-Beef animals, prices were sourced from the weekly 2021/2022 M2 bull schedule for North Island processors (Interest 2023; Table 2). Then for animals in the NGB system, the price ratio (0.83) from the slaughter company Taylor Preston (Interest 2023) for bulls with carcass weights of under 195 kg, was applied to the weekly M2 schedule. For example, Bull-Beef animals with 300 kg carcass weights sold in October would receive $5.89/kg of carcass, while sales of NGB animals in October were for 83% of that value, i.e. $4.89 /kg carcass due to the lower carcass weight. Sale values on a per head basis were then estimated from combining the per kg carcass price with sale liveweight and carcass dressing rate (Purchas et al. 2012; Hunt 2019; Addisu et al. 2023).

Purchase prices for three-month-old Friesian bull calves were $390, $490 and $577 per head for cohorts with average weights of 80, 100 and 120 kg, respectively, based on data from the November Feilding weaner sale (agOnline 2023). The beef enterprise share (46% with the remainder being attributable to the sheep enterprise) of general farm working expenses (including variable and fixed costs such as wages, repairs and maintenance, administration, vehicle and feed-related costs, while excluding animal health costs which were estimated separately) were $69.89 per stock unit according to 2021/2022 farm survey data (Farrell et al. 2021, 2022; BLNZ Economic Service 2023b). A stock unit is the equivalent of approximately 5500 MJ ME consumed per year (Trafford and Trafford 2011), and as total stock units were maintained at the same level across all scenarios evaluated, annual general farm working expenses always totalled $90,222. However, animal health expenses were estimated on a per animal basis at $1.74 per week until reaching one year of age when costs rose to $2.70 per week (Addisu et al. 2023). Harvest, storage and feeding out of baleage was costed at $97 per 166.5 kg DM bale, adjusted from the 2020 figure from BLNZ Economic Service (2020) and for 4.9% inflation (RBNZ 2023). As pasture conservation costs were already included in the feed-related costs in the farm working expenses, the baleage costs for all scenarios were estimated as the difference from the Benchmark Bull-Beef scenario (0% NGB).

Cash operating surplus (COS) was used as a profitability indicator for the beef enterprise for all modelled scenarios, based on the differences between revenues from beef cattle sales and applicable costs (calf purchases, general working expenses and animal health; Shadbolt and Martin 2005). The COS was divided over the beef share of the farm area (46% of 208 ha) for a per hectare expression of COS for the pasture-based systems investigated (Farrell et al. 2021). The COS of the Bull-Beef (Benchmark) and NGB scenarios were estimated for objective one of the current study

For beef finishing farms purchasing three-month-old dairy-origin calves, some farmers may choose to finish these calves with a combination of different liveweights and timings which would represent both Bull-Beef and NGB animals within the same system. In the current analysis, the proportions of stock units, i.e. proportion of total annual beef enterprise feed demand, consumed by Friesian Bull-Beef and NGB animals were varied to simulate Mixed systems and model the resultant COS and monthly feed balance. For objective two of the current study, the proportion of stock units accounted for by NGB within the beef enterprise was varied at 0%, 20%, 40%, 50%, 60%, 80% and 100%, with the remaining stock units within the beef enterprise accounted for by Bull-Beef. The per kg carcass prices for NGB animals were then increased in each applicable scenario (20%, 40%, 50%, 60%, 80% and 100% NGB scenarios) until a break-even price was reached where the COS matched that of the Benchmark Bull-Beef scenario (for objective three of the current study).

Results

The results are divided into three major subsections, each addressing one of the study objectives. First, to establish the potential production and profitability of all NGB (100% NGB) and the Benchmark all Bull-Beef (0% NGB) scenarios. Then to explore the potential profitability of Mixed NGB and Bull-Beef systems. Finally, to determine break-even prices for NGB animals needed for COS to match that of the Benchmark Bull-Beef (0% NGB) scenario.

Comparing the New Generation Beef and Bull-Beef systems

Herbage demand

For the Benchmark scenario (0% NGB), with all Bull-Beef animals grown out to target carcass weights of 270–300 kg, there were 244 total animals purchased each November (consisting of 78, 88 and 78 animals in the slow, medium and fast-growing cohorts, respectively). While maintaining the same total annual feed demand of 7.1 million MJ ME, there were 512 total animals purchased each November (consisting of 164, 184 and 164 animals in the slow, medium and fast-growing cohorts, respectively) for the 100% NGB scenario with NGB animals growing to 300 kg target liveweight at slaughter (equivalent of 150–160 kg carcass weight).

Feed supply from pasture was greatest in spring (October) and least in winter (June and July; Figure 2). In the Benchmark scenario (0% NGB) feed demand peaked in spring (November) when three-month old animals were brought on-farm, then feed demand gradually decreased to be lowest in late-autumn (May) after the last cohort (slow-growing animals) of the previous year's calves had been sold. Feed demand for the 100% NGB system was lowest in spring (September to December) and peaked in autumn (March, April, May) contrasting with the feed supply from pasture. It was assumed in the Benchmark (0% NGB) scenario that baleage was harvested once in October with a surplus of 39 t DM, which was the threshold for pasture conservation in other scenarios, with the conserved pasture assumed to be fed during the winter (June and July) feed deficit (Figure 3). In the 100% NGB scenario conserved pasture via baleage occurred during three months of the year (September, October and November), due to the low spring feed demand.

System performance

Liveweight gain and net carcass sold per hectare are indicators of finishing system productivity (Red Meat profit Partnership 2018) and were 2% greater and 12% less,

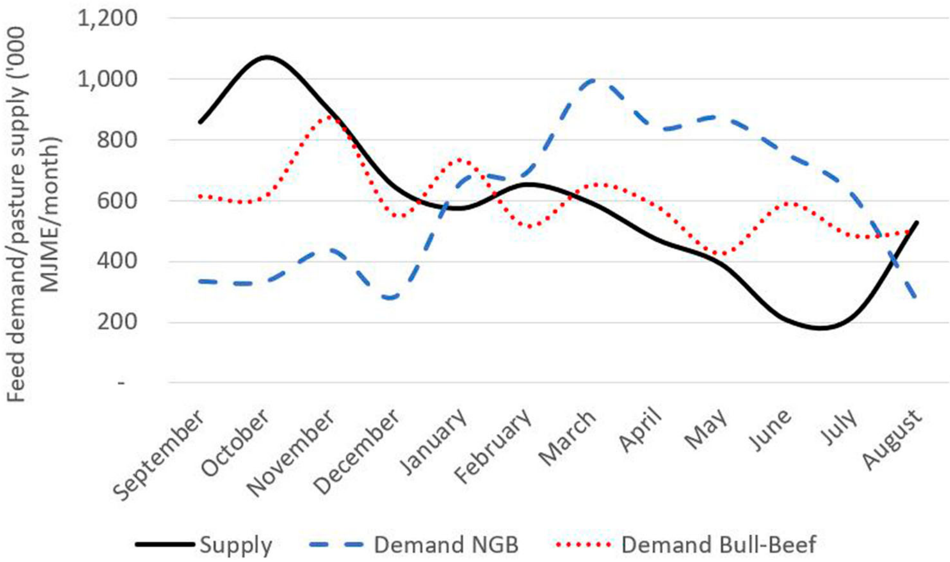

Figure 2. Monthly feed supply from pasture grown only (i.e. before any baleage was made or fed) and monthly feed demand for scenarios with 100% New Generation Beef (NGB) animals or all Bull-Beef animals (0% NGB).

respectively, for the 100% NGB scenario compared with the Benchmark 0% NGB scenario (Table 3). Although the 100% NGB scenario had greater liveweight gain and animals finished per hectare per year compared with the Benchmark 0% NGB scenario, the

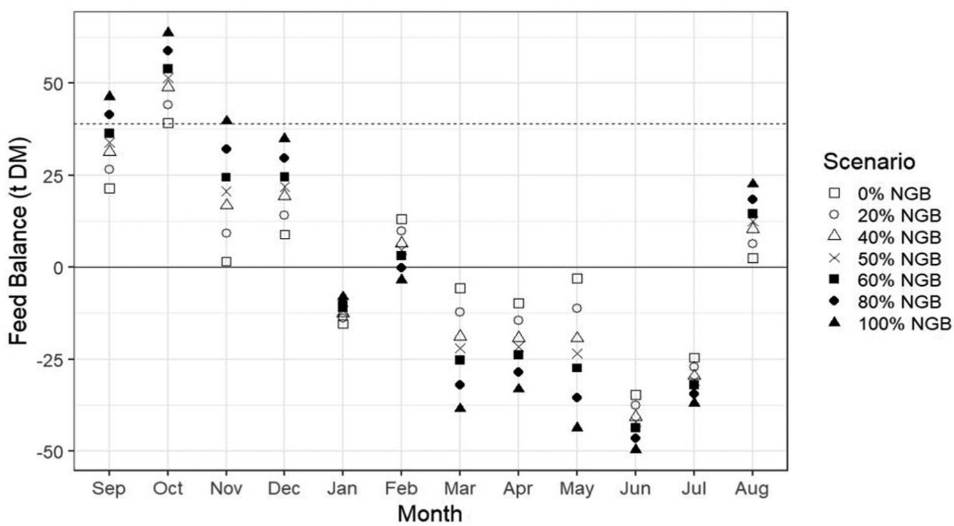

Figure 3. Monthly feed balance as the difference between feed supply from pasture grown and feed demand (see Figure 2 for feed demand of 100% NGB and the Benchmark 0% NGB scenario) for the various beef enterprises including all New Generation Beef (100% NGB) animals, all Bull-Beef animals (0% NGB) or varying proportions of the two. The dashed line indicated the threshold of 39 t DM pasture above which the surplus was harvested as baleage.

Table 3. Model output for scenarios with varying proportions (%) of New Generation Beef (NGB) animals, where the remaining animals were Bull-Beef.

Parameter	Proportion NGB stock units (%)[a]						
	0	20	40	50	60	80	100
Liveweight gain (kg/ha)	1125	1129	1133	1136	1138	1142	1147
Carcass weight purchased (kg/ha)[b]	140	171	202	217	233	264	294
Carcass weight sold (kg/ha)	741	756	772	780	788	804	820
Net carcass weight sold (kg/ha)	600	585	570	563	555	540	526
Baleage made (tDM)	39	44	49	52	54	100	149
Income ($ '000)	421	410	400	395	389	379	368
Calf purchase expenses ($'000)	119	145	171	184	197	223	249
General expenses (excl. animal health and stock purchases) ($'000)	90	90	90	90	90	90	90
Animal health ($'000)	18	18	18	18	19	19	19
Baleage expenses ($'000)[c]	–	3	6	7	9	36	65
Total expenses ($'000)	227	256	285	300	314	368	423
Cash operating surplus ($/ha)	2026	1612	1197	990	783	116	−571
Breakeven NGB price premium (% above current NGB price)[d]	–	29	36	40	44	59	74
Breakeven NGB price premium (% above current Bull Beef price)[e]	–	7	13	17	20	32	44

[a]Where 0% NGB is the Benchmark scenario with only Bull-Beef animals, 100% NGB is a system with only NGB animals, while other scenarios contain a mix of the two.
[b]Assuming a carcass dressing rate of 55% for three-month-old calves.
[c]Baleage expenses were estimated as the difference from the Benchmark scenario (the all-Bull-Beef 0% NGB system).
[d]The price premium needed for NGB animals so that the scenario cash operating surplus equals that of the Benchmark Bull-Beef scenario (0% NGB; $2026/ha), compared to current market prices for NGB animals.
[e]The price premium needed for NGB animals so that the scenario cash operating surplus equals that of the Benchmark Bull-Beef scenario (0% NGB; $2026/ha), compared to current market prices for Bull-Beef animals.

saleable product generated from the system and trading margins were smaller. For example, for medium-growing animals an average purchase price of $490/head was assumed for all scenarios, but the average sale prices were $662/head and $1770/head for NGB and Friesian Bull-Beef animals, respectively. Further, although the total general farm-working and animal-health expenses were similar, there was an additional cost of approximately $65,000 for baleage in the 100% NGB scenario. The Benchmark 0% NGB scenario had a COS of $2026/ha. The 100% NGB scenario had lower total income and greater total expenses than the Benchmark, and negative COS of −$571/ha.

The Mixed system with animals finished as both New Generation Beef and Bull-Beef

The COS was positive for all Mixed scenarios and decreased with higher proportions of non-profitable NGB animals; however, there was a non-linear numerical relationship between COS and the proportion of NGB animals (Table 3). The non-linearity was due to the varying quantity of harvested baleage and incurred costs. As the proportion of NGB animals in the Mixed scenarios increased, the number of months with feed surpluses above the threshold of 39 t DM also increased, i.e. requiring conservation of pasture as baleage and incurring the associated costs (Figure 3). In most scenarios of mixed Bull-Beef and NGB animals pasture conservation occurred only in October as was the case for the all Bull-Beef scenario (0% NGB). However, in the 80% NGB scenario, pasture was conserved in both September and October.

Break-even prices for NGB animals

The break-even price for NGB animals in the Mixed scenarios was greater as the proportion of NGB animals increased (Table 3). The greatest increase in break-even prices was for the 80% and 100% NGB scenarios (Figure 4) where two and three baleage-making events were necessary, compared with one event for remaining scenarios with ≤ 60% NGB (Table 3). The break-even price premiums for NGB animals ranged from 29% to 74% above the current NGB prices which translated to break-even prices above the per kg prices currently received by Bull-Beef animals. Based on the 2021/2022 schedule prices used in this study, the break-even price for slow-growing NGB animals in the 100% NGB scenario would need to be $8.49 /kg carcass weight (Figure 4).

Discussion

Outputs from the model indicate a 100% NGB system is not profitable with the current sale prices received for NGB animals, as indicated by a negative COS (Table 3). The COS for the 100% NGB scenario, compared with the Benchmark Bull-Beef (0% NGB) scenario, was due to less income from lower sale prices on both a per kg carcass and a per head basis; greater total calf purchase costs due to the greater number of animals bought; and greater baleage costs due to the greater spring pasture surplus for the 100% NGB system. The mixed finishing systems (20%–80% NGB scenarios) were also predicted to have lower COS than for the Benchmark Bull-Beef scenario (0% NGB)

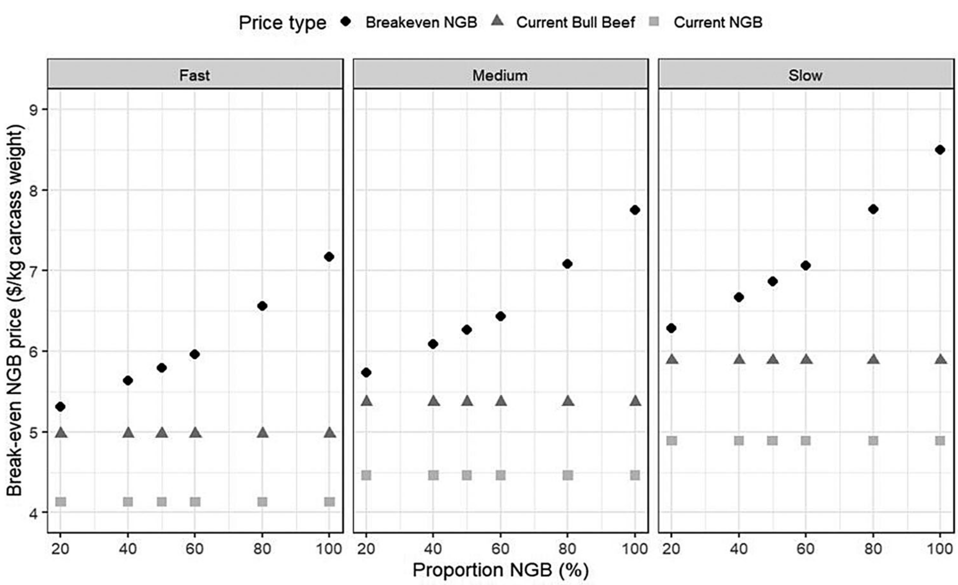

Figure 4. The break-even price ($/kg carcass weight) needed for the cash operating surplus (COS) in the modelled scenarios with varying proportions of New Generation Beef animals (NGB) to equal that of the Benchmark all Bull-Beef system (0% NGB). Current (2021/2022) Bull-Beef and NGB prices are also shown. Prices varied for slow, medium and fast-growing animals due to sale timing. Slow-, medium- and fast-growing NGB animals were sold in June, July and October, respectively. Slow-, medium- and fast-growing Bull-Beef animals were sold in December, February and May, respectively.

due to the previously outlined low profitability of the NGB animals. Past analyses indicate negative returns for NGB animals sold at less than a year of age (Hunt et al. 2019). Ashfield et al. (2014) compared finishing younger bulls at 16–22 months of age with a more conventional system that finished steers at 24 months of age, reporting that the younger finishing age resulted in greater feed surpluses in the pasture-based system. Addisu et al. (2021) modelled effects on farm profit of having up to 25% of stock numbers as NGB animals in a traditional beef finishing system, i.e. a system finishing cattle originating from a beef breeding herd. Authors reported that the lower purchase price of the three-month-old NGB animals compared with purchases of six-month-old beef weaners resulted in expenses being reduced to a larger degree relative to income, thereby increasing profit. The analysis of Addisu et al. (2021) indicated that NGB animals could be profitable as part of the traditional beef finishing system. This was in contrast to the current study, where the inclusion of NGB animals reduced COS compared with the highly profitable Bull-Beef system.

Hunt et al. (2019) suggested price premiums of $0.67–$1.85 per kg carcass weight, 11%–27% above the prevailing schedule price were needed for systems with NGB type animals to break even with Bull-Beef systems. These premiums were lower than the 29%–74% estimated as required for NGB animals in the current study. However, Hunt et al. (2019) assumed the NGB animals would receive P-grade beef steer prices which are greater than the discounted manufacturing beef prices assumed in the current study and did not account for the additional cost of baleage harvest with NGB animals due to the mismatch of feed demand/pasture supply as determined in the current study.

There are existing price premiums available to New Zealand beef farmers, including those for Angus, Wagyu or organically raised animals, with specific eligibility criteria such as using sires from specified breeding programmes. Price premiums above beef-schedule rates have recently been advertised as $0.30 to $1.00 per kg carcass weight for Angus animals (Wallace 2021) and $0.30 to $3.00 per kg carcass weight for Wagyu animals (Alliance 2022). From the break-even analysis in the current study, premiums for NGB animals needed to be $1.18–$3.60 per kg of carcass weight to achieve the same profitability as Bull-Beef systems (Figure 4). This would require the price premiums for NGB animals to be equal to or greater than the best premiums currently available for beef-origin animals. To achieve a premium the product would need to have positive attributes that consumers desire. Meat from NGB animals has relatively low shear force which consumers may identify as being more tender, i.e. compared with meat from an older animal, and is potentially of high eating quality (Pike et al. 2019). In the future, a consumer sensory panel could be used to predict the likelihood of price premiums for meat from NGB animals. Equally, a marketing and branding initiative similar to those for Angus or Wagyu may be necessary for NGB. Addisu et al. (2023) used an agent-based model of the dairybeef supply chain to explore effects of price premiums of up to 20% and no-calf purchase costs on the uptake of NGB systems. Authors reported greater uptake of NGB finishing with incentives, however, due to feed supply dynamics this did not always increase total numbers of dairy-origin animals finished.

The current study modelled NGB animals as being slaughtered at ten to 14 months of age, assuming there is suitable processing capacity for animals of this size, i.e. 147–166 kg carcass weight. In reality there may be limitations in the availability of processing plants which are suitable for animals of these low carcass weights, as the average weights of steer and bull carcasses in New Zealand are approximately 300 kg (BLNZ Economic Service 2022). An alternative destination for NGB animals is the late-winter store market, where they could be sold to another farmer for finishing at typical heavier weights, i.e. 270–300 kg carcass weight, similar to the Bull-Beef animals modelled in this study. The modelled NGB animals in early-August would weigh an average of 255, 318 and 382 kg in the slow, medium and fast-growing cohorts, respectively. Data at the time of this analysis indicate these animals may sell for $1020–$1253/head (agOnline 2023), greater than the slaughter prices of $600–$904/head assumed in the current study (Table 2). This alternative sales option would change the feed demand profile of the NGB scenario towards even greater demand in winter and less demand in spring, as fast-growing animals would then remain on-farm over winter and slow-growing animals sold before spring. The potential greater feed costs required in scenarios with more NGB animals carried over winter compared with the current study could offset some of the increased revenue from animal sales.

In the current study, rates of liveweight gain were based on recent New Zealand studies of Friesian bulls from the dairy farming sector. These growth rates could be expected to be similar for beef-dairy crossbreed bulls but would be expected to be less for steers, heifers and Jersey-cross breed animals. Thus, these animals would likely have lower purchase prices at three months of age (agOnline 2023) but also lower production, and potentially lower profitability than was estimated in the current study. The finishing systems (NGB and Bull-Beef) explored in the current study would likely prefer male animals, particularly bulls, with greater rates of liveweight gain and carcass dressing percentage (Coleman et al. 2023), as indicated by Addisu et al. (2023) with agent-based modelling of the dairy-beef finishing supply chain. However, female dairy-beef crossbreed calves of dairy-origin are farmed in the beef sector. Farrell et al. (2022) identified that well-grown beef-dairy crossbreed cows could improve efficiency and profitability compared with conventional self-replacing beef breeding cow herds. There is also use of beef-dairy crossbreed female animals in 'once bred heifer' systems which have favourable production and economic comparisons (Keeling et al. 1991; Coleman et al. 2023). Parties invested in reducing bobby calf numbers should consider a combination of options for increased integration of the dairy and beef sectors.

Sales of NGB animals in winter, i.e. the medium- and fast-growing cohorts sold in June and July (Figure 1), provides cashflow during a different time of year to lamb sales. In contrast, Bull-Beef animals in this study were assumed to be sold in December, February and April consistent with typical lamb sale timings between late-spring and autumn on this class of farm (MPI 2023). Currently on class five North Island finishing farms, sheep sales make up on average 40%–50% of total farm income (BLNZ Economic Service 2023b). The current study used COS as a profitability indicator which does not include interest on an overdraft loan. Interest costs to the sheep and beef farm business may be lower in scenarios with NGB animals due to additional income in winter reducing overdraft use due to seasonal occurrence of low cashflow.

This study compared finishing NGB animals compared with Bull-Beef within the beef enterprise only, thus implications for monthly feed balances were managed within the beef enterprise though pasture conservation. There is a possibility that the greater spring feed surpluses for the scenarios with greater NGB animals could be utilised by lambs, producing greater lamb weaning weights and younger ages at slaughter which would likely improve the sheep enterprise efficiency and profitability. However, the greater late-autumn and winter feed demand in scenarios with more NGB animals, compared with the Benchmark Bull-Beef (0% NGB) scenario could limit breeding ewe numbers. Further modelling of NGB scenarios should explore possible implications for both the sheep and beef enterprises, with sensitivity analyses around seasonal feed demand and supply and for systems with varying proportions of breeding ewes versus trading lambs or for different climate years with contrasting pasture growth profiles. With current prices received for NGB animals it is unlikely that sheep and beef farmers would increase winter feed through cropping or bought-in supplement to accommodate the NGB feed demand.

Conclusions

The New Generation Beef (NGB) finishing system represents an opportunity for higher throughput rates of dairy-origin animals compared with 18-month Friesian Bull-Beef, with more than double the number of animals able to be finished each year as estimated in the current study. This accelerated finishing system is therefore appealing to the dairy sector as providing a destination for surplus calves. The outputs from this study indicate that to match the profitability of Bull-Beef systems, NGB animals require price premiums of up to a 74% greater than those currently received for animals of this type, equal to premiums of $3.60 per kg of carcass weight above the current applicable schedule price. Beef sector uptake of NGB systems is likely to be limited by this lower profitability.

Funding and declaration

This work received no external funding. Lydia Farrell’s time was funded by New Zealand dairy farmers through DairyNZ Ltd. The authors report there are no competing interests to declare.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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References

Addisu AH, Blair HT, Kenyon PR, Morris ST, Schreurs NM. 2021. Optimization of profit for pasture-based beef cattle and sheep farming using linear programming: young beef cattle production in New Zealand. Agric. 11(9):849. doi:10.3390/agriculture11090849.

Addisu AH, Blair HT, Kenyon PR, Morris ST, Schreurs NM, Garrick DJ. 2023. Agent-based modelling to improve beef production from dairy cattle: young beef production. Agric. 13(4):898. doi:10.3390/agriculture13040898.

agOnline. 2023. Sale report; [accessed 2023 June 1]. https://www.agonline.co.nz/sales-report.
Alliance. 2022. Alliance launches Wagyu premium programme; [accessed 2023 June 1]. https://www.alliance.co.nz/news/2022/2/alliance-launches-wagyu-premium-programme/#:~:text = Carcases%20must%20meet%20certain%20marbling,kilo%20above%20the%20schedule%20price.
Ashfield A, Wallace M, Prendiville R, Crosson P. 2014. Bioeconomic modelling of male Holstein-Friesian dairy calf-to-beef production systems on Irish farms. Irish J Agric Food Res. 53: 133–147.
Beauchemin KA, Lachance B, St.-Laurent G. 1990. Effects of concentrate diets on performance and carcass characteristics of veal calves. J Anim Sci. 68(1):35–44. doi:10.1093/ansci/68.1.35.
BLNZ. 2017. Guide to beef cattle farming; [accessed 2023 June 1]. https://beeflambnz.com/knowledge-hub/PDF/guide-new-zealand-cattle-farming.pdf.
BLNZ Economic Service. 2020. Supplementary feed guide; [accessed 2023 June 1]. https://beeflambnz.com/sites/default/files/factsheets/pdfs/fact-sheet-260-Cost%20of%20Feed.pdf.
BLNZ Economic Service. 2022. Compendium of New Zealand farm facts; [accessed 2023 June 1]. https://beeflambnz.com/sites/default/files/data/files/Compendium-22.pdf.
BLNZ Economic Service. 2023a. Farm classes; [accessed 2023 June 1]. https://beeflambnz.com/data-tools/farm-classes.
BLNZ Economic Service. 2023b. Sheep and Beef farm survey; [accessed 2023 June 1]. https://beeflambnz.com/data-tools/benchmark-your-farm.
Burggraaf V, Stevens D, Vibart R. 2018. The effect of grazing state on pasture quality and implications for the New Zealand Greenhouse gas inventory; [2023 June 1]. https://www.mpi.govt.nz/dmsdocument/32866/direct.
Coleman LW, Hickson RE, Schreurs NM, Martin NP, Kenyon PR, Lopez-Villalobos N, Morris ST. 2016. Carcass characteristics and meat quality of Hereford sired steers born to beef-cross-dairy and Angus breeding cows. Meat Sci. 121:403–408. doi:10.1016/j.meatsci.2016.07.011.
Coleman LW, Schreurs NM, Kenyon PR, Morris ST, Hickson RE. 2023. Growth, carcass and meat quality characteristics of Charolais-sired steers and heifers born to Angus-cross-dairy and Angus breeding cows. Meat Sci. 201:109178. doi:10.1016/j.meatsci.2023.109178.
Cosgrove GP, Clark DA, Lambert MG. 2003. High production dairy-beef cattle grazing systems: a review of research in the Manawatu. N Z Grassl Assoc. 65:21–28. doi:10.33584/jnzg.2003.65.2511.
Coutinho HB, Matthews PNP, Morris ST. 1998. The effect of grazing management on pasture and animal production in late autumn to early spring period in a one year bull beef grazing system. N Z Soc Anim Prod. 58:236–238.
Edwards JP, Cuthbert S, Pinxterhuis JB, McDermott A. 2021. The fate of calves born on New Zealand dairy farms and dairy farmer attitudes towards producing dairy-beef calves. N Z J Anim Sci Prod. 81:179–185.
Farrell LJ, Morris ST, Kenyon PR, Tozer PR. 2021. Simulating beef cattle herd productivity with varying cow liveweight and fixed feed supply. Agric. 11(1):35. doi:10.3390/agriculture11010035.
Farrell LJ, Morris ST, Kenyon PR, Tozer PR. 2022. Simulating the productivity and profitability of a herd of beef-dairy crossbred breeding cows on New Zealand hill country with fixed feed supply. Livest Sci. 260:104924. doi:10.1016/j.livsci.2022.104924.
Hunt J, Tozer P, Kenyon P, Schreurs N, Pike S, Hickson R, Blair H, Garrick D. 2019. Brief Communication: relative cost of producing carcasses from dairy-origin steers slaughtered at 8–12 months of age in New Zealand. N Z J Anim Sci Prod. 79:153–155.
Hunt JJ. 2019. Viability of dairy-origin calves for a new beef production enterprise in New Zealand [master's thesis]. Palmerston North, New Zealand: Massey University.
Interest. 2023. M2 Bull schedule prices; [accessed 2023 June 1]. https://www.interest.co.nz/charts/rural/m2-bull2.
isee systems. 2023. STELLA Architect; [accessed 2023 June 1]. https://www.iseesystems.com/store/products/stella-architect.aspx.
Journeaux PR, McRae AF, Parker WJ. 1987. Bull beef production on hill country. N Z J Anim. Sci Prod. 47:119–122.

Keeling P, Morris ST, Gray DI, Parker WJ. 1991. A modeling study of once-bred heifer beef production. N Z Soc Anim Prod. 51:389–393.
Litherland AJ, Woodward SJR, Stevens DR, McDougal DB, Boom CJ, Knight TL, Lambert MG. 2002. Seasonal variations in pasture quality on New Zealand sheep and beef farms. N Z. Soc Anim Prod. 62:138–142.
McRae AF. 1988. Bull beef production: The 'Tuapaka' experience. N Z Grassl Assoc. 49:41–45. doi:10.33584/jnzg.1988.49.1804.
Morris ST. 2019. A precis of beef-cattle research over the last 45 years. N Z J Anim Sci Prod. 79:188–197.
Morris ST, Hickson RE. 2016. An overview of current and potential hill country livestock systems. N Z Grassl Assoc Res Prac Series. 16:309–315. doi:10.33584/rps.16.2016.3236.
MPI. 2023. Data; [accessed 2023 Aug 21]. https://www.mpi.govt.nz/resources-and-forms/economic-intelligence/data/.
Muir PD, Nieuwenhuis G, Smith NB, Ormond AWA. 2000. A comparison of rearing systems for dairy beef calves. N Z Grassl Assoc. 62:9–11. doi:10.33584/jnzg.2000.62.
Nicol AM, Brookes IM. 2007. The metabolisable energy requirements of grazing livestock. In: Rattray PV, Brookes IM, Nicol AM, editor. Pasture and supplements for grazing animals. Hamilton, New Zealand: New Zealand Society of Animal Production Occasional Publication; p. 151–172.
Pettigrew EJ, Morris ST, Back PJ, Kenyon PR, Berry J, Donald AJ, Lane AL, Hickson RE. 2017. Growth of weaned Friesian bull calves on a herb sward or with concentrate supplementation during late summer and early autumn. N Z J Agric Res. 60:70–79. doi:10.1080/00288233.2016.1259641.
Pike S, Schreurs N, Hickson R, Hunt J, Kenyon P, Garrick D, Blair H, Morris S. 2019. BRIEF COMMUNICATION: meat quality of light-weight, yearling steers of dairy origin. N Z J Anim Sci Prod. 79:156–158.
Primary Industries Standing Committee. 2007. Nutrient requirements of domesticated ruminants. Melbourne, Australia: CSIRO Publishing.
Purchas RW, Morris ST, Grant DA. 2012. A comparison of characteristics of the carcasses from Friesian, Piedmontese× Friesian, and Belgian Blue× Friesian bulls. N Z J Agric Res. 35 (4):401–409. doi:10.1080/00288233.1992.10421348.
RBNZ. 2023. Inflation calculator; [accessed 2023 July 1]. https://www.rbnz.govt.nz/monetary-policy/about-monetary-policy/inflation-calculator.
Red Meat profit Partnership. 2018. A core set of KPI measures for red meat farming businesses; [accessed 2023 Dec 7].
Shadbolt N, Martin S. 2005. Farm management in New Zealand. Melbourne, Australia: Oxford University Press.
Trafford G, Trafford S. 2011. Farm technical manual. Christchurch, New Zealand: Lincoln University.
Wallace N. 2021. AGL, Angus Pure extend premium portfolio; [accessed 2023 Aug 1]. https://issuu.com/farmersweeklynz/docs/fw_19-07_issuu.