

# Comparing autumn and spring calving systems: A farm system study on a commercial-scale dairy farm in coastal Taranaki

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## Abstract

In recent years, there has been a growing interest in shifting the calving system from spring to autumn on dairy farms on New Zealand's north island. This change is driven by dry summers, particularly in coastal areas and an increased winter milk premium from Fonterra. In the present study, two farmlets were established to compare autumn calving and spring calving systems and to investigate how the calving systems would affect different aspects of the farming business on a commercial size dairy farm. The study was run over three seasons (2019/2020, 2020/2021, 2021/2022) and the farmlets were compared on milk production, supplements fed and harvested, mating performance, animal health and profitability. The autumn farmlet produced 10 – 23% more milksolids per cow and 5 – 21% more milksolids per hectare than the spring farmlet. The requirement for supplements was 30 – 68% higher and the profitability was 16 – 59% higher for the autumn farmlet, the latter due to higher milk production combined with a winter milk premium. The study shows that it can be possible to increase farm profitability by changing the farming system from spring to autumn calving, especially in summer dry areas.

**Keywords:** dairy farm profitability, milk production, seasonal calving, supplementary feed, summer dry

## Introduction

In the New Zealand dairy industry, the majority of cows calve in spring. In a spring calving system, the herds typically calve in late winter and early spring (July/August in the southern hemisphere). This calving system has been established due to peak grass growth often being in spring/early summer with low growth during the winter months (Garcia and Holmes 1999). However, pasture growth during the summer months can be variable, increasing milk production risks (Tait et al. 2005). Dry summers with long periods of soil moisture deficits lead to low pasture growth and in many areas of the north island of New Zealand dry summers have been identified as becoming increasingly challenging for dairy farmers (Babylon et al. 2023). In some coastal Taranaki areas dry summers with long periods of soil moisture deficits have become a major inhibiting factor on pasture production, while at the

same time, milder winters are giving increased pasture growth during the winter months. In summer 2025 a drought was declared in the Taranaki region.

In recent years there has been an increasing interest in changing the farming system from spring to autumn calving or a split calving system to mitigate the risks of dry summers and to take advantage of the greater winter pasture growth in these areas, in attempt to better aligning pasture demand to pasture growth. In 2017 Fonterra increased the winter milk premium to encourage supply of milk during the winter months to meet market demands and for production of short shelf-life products (Chikazhe et al. 2017). This gave farmers an additional incentive to consider changing from a spring to an autumn calving system.

A modelling study comparing an autumn calving (April) and a spring calving system (July) concluded that some farms might increase their profitability by changing from a spring to an autumn calving system (Chikazhe et al. 2017). This was more likely to be sustainable in regions that are dry in summer and grow more pasture in winter such as in the Northland region. The profitability of the autumn calving system was sensitive to the winter milk premium.

Farmlet studies comparing spring and autumn calving systems in New Zealand have previously been published. A three-year trial was performed at Massey University in Palmerston North on the North Island of New Zealand (Garcia et al. 2000). The study was performed as a three-farmlet study with one autumn calving herd, one spring calving herd and one herd in which 50% of the herd was calved in spring and 50% of the herd was calved in autumn. The study showed that the autumn herd produced more milksolids per cow than the spring herd. The lactation curves for the spring calving cows followed the expected shape with a peak after calving and then a steady decline (Garcia and Holmes 2001). The lactation curves for the autumn calving cows had a lower yield at peak of lactation but higher yields in mid and late lactation. The autumn calving cows also had a longer lactation length. The longer lactation combined with the higher yields in mid and late lactation led to higher total milk yields per cow for the autumn calving cows. There was no significant difference in milksolids per hectare (ha) due to a lower stocking rate on the autumn farmlet. More supplements

were fed on the autumn farmlet but no analysis of the overall profitability of the farmlets was presented.

Northland Agricultural Research Farm performed a three-year trial (1997 – 2000) comparing an autumn calving and a spring calving system (Northland Dairy Development Trust 2000). The autumn calving herd produced more milksolids per cow but less milksolids per ha due to a lower stocking rate on the autumn farmlet. More supplements were fed per cow on the autumn farmlet. The autumn calving system was more profitable due to the winter milk premium. Similar to the modelling study, the profitability of the autumn calving system was sensitive to the winter milk premium and the cost of the supplements.

Another study was performed by DairyNZ comparing four different calving systems with calving dates in January, April, July and October (Spaans et al. 2019). The study was performed over two lactation periods in the Waikato. The April and the July calving dates represented a New Zealand autumn and spring calving system respectively. In this study each farmlet had the same stocking rate. The aim of the study was to study the biophysical and economic effects of different calving seasons in a pasture-based system without importing any additional feed. Silage was made and fed within each farmlet. The study concluded that calving in late winter (July) was most profitable in a grazing system where additional feed was not imported. This conclusion was valid both with and without a winter milk premium. The July calving farmlet produced more milksolids per cow and per ha than any of the other farmlets. 15% more milksolids per cow and per hectare was produced on the July farmlet compared with the April farmlet.

The studies described above indicate that an autumn calving system may have a higher milk production per cow than a spring calving system if the stoking rate is reduced and supplements are fed. There are limited comparisons available of the overall profitability of autumn and spring calving systems in New Zealand. The study from the Northland Agricultural Research Farm (Northland Dairy Development Trust 2000) indicated that an autumn calving system can be more profitable if the stocking rate is reduced, and additional feed is imported. The study from Spaans et al. (2019) indicates that if stocking rates are kept the same and no additional feed is imported, a spring calving system would be more profitable.

In this paper a commercial-scale study on the comparison of an autumn calving system and a spring calving system is presented. The aim of the study was to investigate how the calving system would affect different aspects of the farming business.

## Materials and Methods

The study was performed on the Dairy Trust Taranaki research farm Kavanagh, located at the coast on the outskirts of Hawera in South Taranaki (39°36'34" S, 174°17'21" E). The pastures consisted of predominantly ryegrass (*Lolium perenne* L.) and white clover (*Trifolium repens* L.). The study was performed over three full seasons, Season 1: 2019/2020, Season 2: 2020/2021 and Season 3: 2021/2022. To be able to directly compare the two farming systems the seasons were defined as running from 1<sup>st</sup> of June to 31<sup>st</sup> of May on both farmlets as is standard for spring calving systems.

## Experimental design

In October 2017 602 predominantly Friesian cows from the Kavanagh farm were randomly allocated into two herds, one autumn calving herd (AUT, n=301) and one spring calving herd (SPR, n=301) and blocked on age, breeding worth, production worth, current daily milk solids production, cumulative-to-date milk solid production, days in milk, liveweight, body condition score (BCS), and somatic cell count. Heifers grazing off the milking platform were randomly allocated to each farmlet and checked they were balanced for liveweight (n=22 for AUT and n=19 for SPR). The spring herd was mated that month and continued in a standard spring calving system. The autumn herd completed an 18-month extended lactation period, omitting the mating in spring 2017. They were mated in June – August 2018 to calve in March 2019. The mating dates for the heifers were changed according to the herd allocations so heifers for the autumn herd returned to the milking platform in February 2019 (30 months old) to be calved in March 2019. On the spring farmlet the heifers returned from grazing in June each year. The data from the transition of the autumn calving herd and the extended lactation has been summarised and published by Jarman et al. (2020b) and Jarman (2020a). The data from the transition period is not part of the study presented in this paper. The present study focuses on the comparison of the spring calving herd and the autumn calving herd over three complete seasons after the autumn herd was established.

In October 2017 the paddocks of the Kavanagh farm were randomly allocated to each farmlet. The paddocks were blocked for location, distance to milking parlour, soil fertility, pasture species and age, previous cropping history and effluent application, Olsen P, and Quick test potassium levels. Thirty paddocks (104.8 ha) were assigned to the autumn farmlet, and twenty-nine paddocks (104.0 ha) were assigned to the spring farmlet. Each paddock was around 4 – 5 ha. The stocking rate at the start of the present study was 2.9 cows per ha for both farmlets.

## Experiment management

Daily operational decisions were made for the two farmlets independently, following similar farming practice as described by MacDonald and Penno (1998). For the majority of the lactation periods the cows in both herds were milked twice a day through the same milking parlour. The milk from each herd was collected into separate vats and supplied with two different supply numbers. Sick or lame cows from both herds were grazed together in one mob that was rotated between paddocks from both farmlets. Young stock was grazed off farm post weaning for both herds.

Nitrogen (N) was applied behind the cows on both farmlets from June – December at a rate of 28 – 37 kg N/ha. Gibberellic acid was applied to the autumn farmlet following the cows for two rotations in June – August to improve pasture growth over the winter months. Overall, the amounts of N applied over the three seasons were: Season 1 - AUT: 219 kg N/ha, SPR: 194 kg N/ha, Season 2 - AUT: 227 kg N/ha, SPR: 180 kg N/ha, Season 3 - AUT: 179 kg N/ha, SPR: 159 kg N/ha. Seven paddocks from each farmlet received effluent treatments (28 ha per farmlet). No N-fertiliser was applied to these paddocks.

Surplus pasture was conserved as silage or hay on both farmlets. About 4.5 – 5 ha of maize was planted each season on both farmlets. About 4 ha of Turnips were grown on the spring farmlet each season.

In addition to harvested supplements, a palm kernel expeller (PKE)-based meal mixture was fed using an in-shed feeding system. The PKE-based meal mixture was fed when pasture supply and availability of home-grown supplement was below feed demand, to fill the deficit in the feed budget to meet target grazing residuals and rotation length.

The autumn calving herd was mated in June and the spring calving herd in October. Mating management policy was the same for both farmlets. In Season 1 and 3 mating was a total of 11.5 weeks. Artificial breeding (AB) was performed for 5 – 6 weeks followed by natural matings with Hereford bulls. In season 2 only AB was performed for 12 weeks.

## Measurements

Daily rainfall was recorded from a weather station located on the Kavanagh farm.

Individual paddock pasture cover was measured weekly for both farmlets using a combination of a rising plate meter and a calibrated visual assessment of each paddock. The pasture growth rate (kg DM/ha/day) was calculated by dividing the increase in pasture cover by the days between measurements excluding grazing events and negative values.

The annual pasture production of each paddock was calculated by totalling the weekly pasture production.

The average pasture production for each farmlet was calculated by averaging the individual paddock yields.

The yield of pit silage was determined from weighbridge records of wet weight and assessment of dry matter content. Set values of 180 kg DM and 300 kg DM were estimated for silage and hay bales respectively.

Each cow was weighed monthly and the BCS of each cow was evaluated monthly by a trained assessor (1-10 scale, 0.5 increments, Roche et al. 2009).

Animal health was monitored throughout the trial and treated cases of mastitis and lameness were recorded.

The empty rates were calculated based on the number of cows scanned empty at pregnancy testing.

Milk production data was obtained from bulk milk analysis of milk supplied to Fonterra.

## Statistical analysis

A two-sample t-test was used to determine the difference of means. Significance was declared at  $P \leq 0.05$ . The statistical analysis was completed using R software (R Core Team 2024).

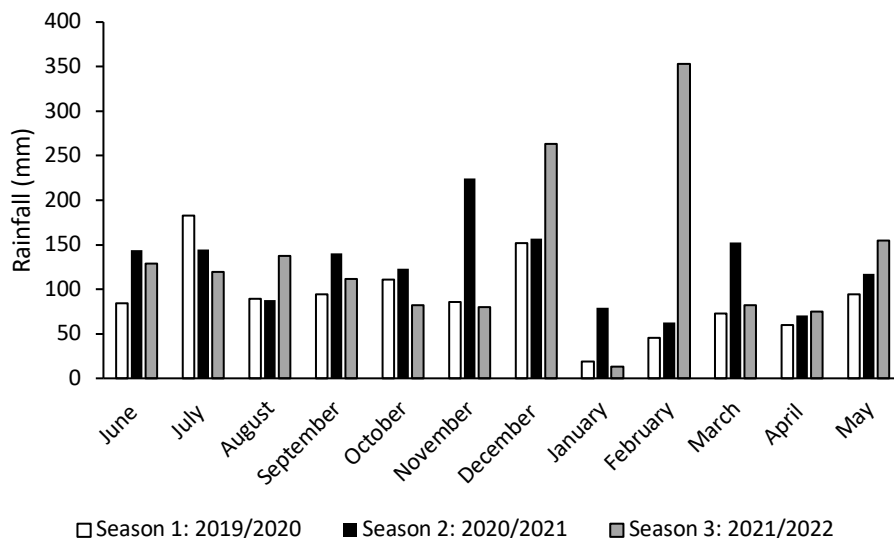
## Financial calculations

Where available, financial numbers from each farmlet were used for the economic analysis. Where the items could not be separated for each farmlet such as electricity, repairs and maintenance and depreciation, numbers from a commercial database used for benchmarking economic performance of farms in New Zealand was used (DairyBase, DairyNZ, Hamilton, New Zealand). Numbers from spring calving farms in the Taranaki region were used (Season 1: n=91 farms, Season 2: n=94 farms, Season 3: n=87 farms).

The revenue from the milk produced was calculated based on the Fonterra milksolids (MS) price for the respective seasons. Farm gate milk price: Season 1: 7.14 NZ\$/kg MS, Season 2: 7.54 NZ\$/kg MS, Season 3: 9.30 NZ\$/kg MS.

Winter milk premiums for milk supplied 16<sup>th</sup> of May – 15<sup>th</sup> of July: Season 1 and 2: 2.85 NZ\$/kg MS, Season 3: 3.15 NZ\$/kg MS. In addition, for all three seasons there was a 0.65 NZ\$/kg MS peak premium for milk produced between 1<sup>st</sup> of June – 30<sup>th</sup> of June. For all three seasons an adjustment factor of 0.35 NZ\$/kg MS was deducted for transport of the milk to the factory as the winter milk had to be transported further than normal for processing.

The costs used for home grown pasture silage and hay was based on an average from the three years of the trial: pit silage 0.14 NZ\$/kg DM, silage bales 0.27 NZ\$/kg DM, hay 0.13 NZ\$/kg DM. The cost used for bought silage bales and hay was based on the average prices from the local contractor for the individual seasons. Cost of bought silage bales for Season 1 was 0.51 NZ\$/



**Figure 1** Monthly rainfall (mm) for Seasons 1-3 of the trial.

**Table 1** Average annual pasture production (t DM/ha) on the spring and autumn farmlet for Seasons 1 - 3 of the trial as estimated from weekly pasture cover measurements. SED = standard error of difference, significance was declared at  $P \leq 0.05$ . No significant difference was found between the two farmlets.

	Pasture production (t DM/ha)		P value	SED
	AUT	SPR		
Season 1	9.13	9.32	0.63	0.39
Season 2	11.34	11.97	0.12	0.40
Season 3	11.55	11.18	0.36	0.40

kg DM, and the cost of bought hay bales was 0.29 NZ\$/kg DM. The cost of bought hay bales for Season 2 and 3 was 0.34 NZ\$/kg DM and 0.39 NZ\$/kg DM respectively. No silage was bought in Season 2 and 3.

## Results

### Rainfall and pasture production

Monthly rainfall varied between the different seasons of the trial (Figure 1). January and February in Season 1 had particularly low amounts of rain. Season 1 had lower amounts of rain from January to May than the following two seasons (Season 1: 292 mm, Season 2: 482 mm, Season 3: 679 mm).

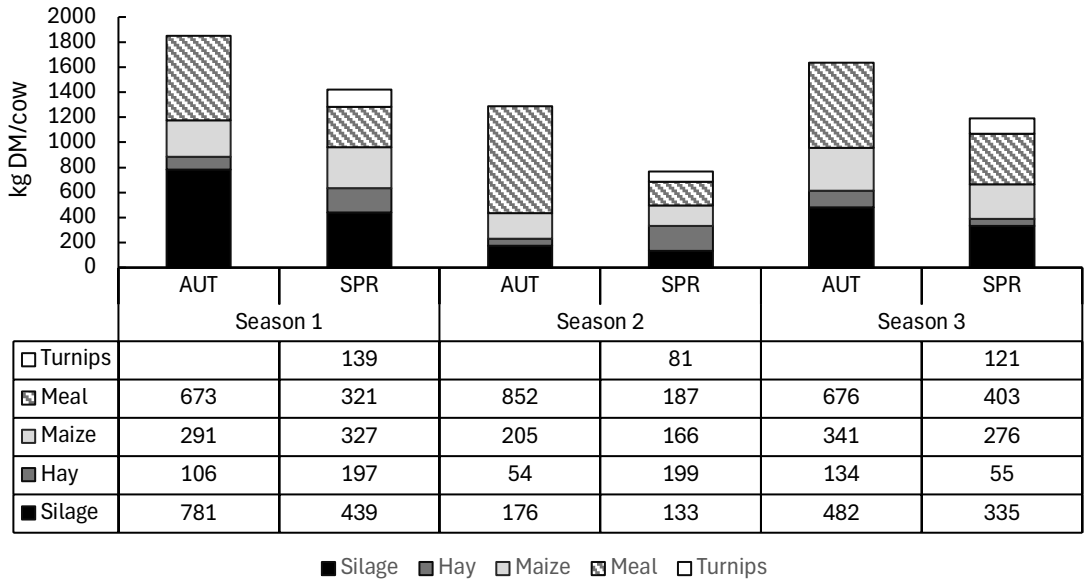
The annual pasture production was lower in the first season of the trial than in the two following seasons due to the dry conditions in January - May 2020 (Table 1). There was no significant difference in annual pasture production between the autumn and the spring farmlet.

### Supplements

Supplements were fed throughout the trial according to demand and pasture growth to achieve target BCS of

the cows and target post-grazing residuals. The highest amount of supplements were fed in the first season on both farmlets (Figure 2, AUT: 1851, SPR: 1423 kg DM/cow). Substantially less supplements were fed in the second season (AUT: 1287, SPR: 766 kg DM/cow) while more supplements were fed again in the third season (AUT: 1633, SPR: 1190 kg DM/cow). More supplements in total were fed to the autumn herd in all three seasons. In Season 1, 30% more supplements were fed to the autumn herd while 68% and 37% more supplements were fed in Season 2 and 3 respectively.

Surplus pasture was conserved as silage and hay on both farmlets. Slightly more silage was harvested on the spring farmlet in the first season (AUT: 126 t DM, SPR: 132 t DM). In the second season more silage was harvested on both farmlets due to higher pasture production (AUT: 169 t DM, SPR: 163 t DM) with slightly more silage harvested on the autumn farmlet. In Season 3 the pasture production was only slightly lower than in the second season. However, pasture growth was low during winter and spring when feed demand was high on the autumn farmlet, and pasture



**Figure 2** Supplements fed throughout the three seasons of the trial (kg DM/cow). Meal (PKE-based mix), maize silage, hay and pasture silage was fed on both farmlets, and turnips were fed on the spring farmlet only.

**Table 2** Total kg MS produced and kg MS/cow and kg MS/ha for the autumn and spring herd for Seasons 1 – 3 of the trial. Days in milk, peak cows milked, and stocking rate is also reported.

	Season 1		Season 2		Season 3	
	AUT	SPR	AUT	SPR	AUT	SPR
Total kg MS	149,823	122,885	145,804	129,640	131,361	123,820
kg MS/cow	491	400	478	426	451	411
kg MS/ha	1,430	1,182	1,391	1,247	1,253	1,190
Days in milk	313	271	310	295	317	289
Peak cows milked	305	307	305	304	291	301
Stocking rate (cows/ha)	2.9	2.9	2.9	2.9	2.8	2.9

growth was high in summer and autumn when feed demand was lower. This led to a large amount of pasture conserved as silage on the autumn farmlet (AUT: 204 t DM). Less silage was conserved on the spring farmlet as feed demand was higher in summer and autumn due to the cows still lactating (SPR: 130 t DM). Only small amounts of hay were conserved on the farmlets (Season 2 - AUT: 9 t DM, Season 3 - SPR: 3 t DM).

### Milk production

The autumn herd produced more milksolids in total and more milksolids per cow and per ha (Table 2). In Season 1 the autumn herd produced 23% more kg MS/cow and 21% more kg MS/ha. In Season 2 the difference was 12% more kg MS/cow and 12% more kg MS/ha and in Season 3 the autumn herd produced 10% more kg MS/cow and 5% more kg MS/ha. The autumn herd had more days in milk than the spring herd (AUT: 310 – 317

days, SPR: 271 – 295 days). The spring herd had the lowest days in milk in Season 1, when due to the dry conditions and low pasture growth in the autumn, the cows were dried off in early April. In the following two seasons the cows in the spring herd were dried off in early May. All cows in the spring herd were also milked once a day from February in the first season.

### Animal health and mating performance

In the first season, there was no significant difference in average BCS between the autumn and spring herd at calving (Table 3). In the following two seasons, the autumn herd had a higher average BCS at calving. The autumn herd also had higher average BCS at mating in all three seasons. The largest difference in average BCS was seen at dry off where the autumn herd had a significantly higher average BCS.

**Table 3** Average BCS at calving, mating and dry-off for the autumn and spring herd for Seasons 1 – 3 of the trial. SED = standard error of difference. Significance was declared at  $P \leq 0.05$  (marked in bold).

Season 1				
	AUT	SPR	P value	SED
Calving <sup>1</sup>	5.08	5.03	0.44	0.06
Mating <sup>2</sup>	4.28	4.19	<b>0.01</b>	0.04
Dry off <sup>3</sup>	4.61	4.27	<b>&lt;0.0001</b>	0.04
Season 2				
Calving <sup>1</sup>	5.16	5.01	<b>0.0002</b>	0.04
Mating <sup>2</sup>	4.25	4.33	<b>0.01</b>	0.03
Dry off <sup>3</sup>	4.70	4.23	<b>&lt;0.0001</b>	0.04
Season 3				
Calving <sup>1</sup>	5.03	4.92	<b>0.02</b>	0.05
Mating <sup>2</sup>	4.34	4.24	<b>0.0005</b>	0.03
Dry off <sup>3</sup>	4.58	4.19	<b>&lt;0.0001</b>	0.04

<sup>1</sup>SPR: July, AUT: February, <sup>2</sup>SPR: October, AUT: June, <sup>3</sup>SPR: May, AUT: January

There was no clear trend in terms of differences in treated cases of mastitis and lameness for the two herds (Table 4). In the first season, the autumn herd had a higher number of treated mastitis (AUT: 118, SPR: 72) and lameness cases (AUT: 36, SPR: 21). However, in the second season the spring herd had a higher number of mastitis cases (AUT: 86, SPR: 107), and the two herds had the same number of lameness cases (31). In the third season, the spring herd had a higher number of mastitis (AUT: 42, SPR: 64) and lameness cases (AUT: 56, SPR: 59). There was a significant reduction in treated mastitis cases for both herds in the third season of the trial compared to the previous seasons while the number of lameness cases increased.

Overall, the autumn herd had a 2 – 4%-point higher empty rate than the spring herd. In Season 1 and 3, when bulls were used for natural matings at the end of the mating period, both herds achieved good reproductive results with empty rates of 12% and 13% for the autumn herd and 10% and 9% for the spring herd.

**Table 4** Treated cases of mastitis and lameness and empty rates (%) for the autumn and spring herds in Seasons 1 – 3 of the trial.

	Season 1		Season 2		Season 3	
	AUT	SPR	AUT	SPR	AUT	SPR
Mastitis	118	72	86	107	42	64
Lameness	36	21	31	31	56	59
Empty rate (%)	12	10	22	19	13	9

In Season 2, the empty rate was significantly higher on both farmlets, likely due to the exclusive use of AB throughout the entire mating period without the use of bulls. This led to the reintroduction of bulls in Season 3.

### Financial analysis

A financial analysis was performed to compare the profitability of the two farmlets (Table 5). The gross farm revenue was higher for the autumn farmlet due to higher milk production and the winter milk premium (Season 1: 31%, Season 2: 21%, Season 3: 12%). The winter milk premium contributed to 6.5 – 7.6% of the gross farm revenue for the autumn farmlet.

The autumn farmlet also had higher operating expenses (Season 1: 11%, Season 2: 19%, Season 3: 9%). The feed expenses were higher on the autumn farmlet due to a higher requirement for supplements (Season 1: 34%, Season 2: 84%, Season 3: 32%). The fertiliser expenses were also higher on the autumn farmlet (Season 1: 27%, Season 2: 25%, Season 3: 14%) due to higher amounts of N-fertiliser used and Gibberellic acid being used in winter to promote pasture growth when the autumn herd was at peak lactation.

Despite the higher operating expenses, the autumn farmlet had a higher operating profit than the spring farmlet all three seasons (Season 1: 59%, Season 2: 23%, Season 3: 16%). On an average over the three Seasons of the trial the autumn farmlet was 33% more profitable than the spring farmlet.

Without the winter milk premium, the autumn farmlet would still have been 35% more profitable in Season 1 and 5% more profitable in Season 2. However, in season 3 the autumn farmlet would have been slightly less profitable (-0.4%). With the winter milk premium reduced by 50%, the autumn farmlet would have been 47% more profitable in Season 1, 14% more profitable in Season 2 and 8% more profitable in Season 3.

### Discussion

The requirement for supplements was 30 - 68% higher on the autumn farmlet. This was due to the autumn farmlet having a higher feed demand during the winter months when the autumn herd was at peak lactation while pasture growth was low. A higher requirement for supplements in autumn calving systems was also found in previously reported farmlet studies (Garcia et al. 2000; Northland Dairy Development Trust 2000). The demand for supplements was highest in the first season when pasture production was low due to the dry conditions. In the second season pasture production increased and the demand for supplements was lower. More supplements were fed again the third season despite the pasture production being similar to the second season. A low pasture growth during winter and spring when the feed demand was high combined with

**Table 5** Economic analysis of the profitability of the autumn and spring farmlet for Seasons 1 – 3 of the trial (all numbers given as NZ\$/ha excluding GST)<sup>1</sup>

	Season 1		Season 2		Season 3	
	AUT	SPR	AUT	SPR	AUT	SPR
<i>Revenue</i>						
Milk sales	10,207	8,437	10,490	9,399	11,657	11,072
Winter milk premium	913		915		887	
Other income <sup>2</sup>	893	716	931	802	1010	1039
Gross farm revenue	12,013	9,153	12,336	10,201	13,554	12,111
<i>Operating expenses</i>						
Labour	1,129	1,129	1,221	1,221	1,347	1,347
Stock	619	619	894	757	994	996
Feed	1,854	1,379	1,525	827	1,929	1,456
Fertiliser	546	429	653	523	836	731
Other working expenses	914	898	995	987	1,185	1,181
Overheads	857	857	915	915	947	947
Total operating expenses	5,918	5,311	6,204	5,229	7,238	6,658
Operating profit <sup>3</sup>	6,095	3,841	6,133	4,972	6,316	5,453
Operating profit w/o winter milk premium	5,182	-	5,217	-	5,429	-
Operating profit with 50% winter milk premium	5,639	-	5,675	-	5,873	-

<sup>1</sup>For more details on the economic analysis see the materials and methods section. <sup>2</sup>Other income: stock sales. <sup>3</sup>Gross farm revenue minus operating expenses.

a high pasture growth later in the season when feed demand was lower resulted in a poorer alignment of pasture growth with feed demand in the third season. A higher amount of pasture therefore had to be conserved as silage on the autumn farmlet.

The autumn herd had 10 - 23% higher milk production per cow than the spring herd. In contrast to previously reported studies (Garcia et al. 2000; Northland Dairy Development Trust 2000), the autumn farmlet also produced 5 - 21% more milksolids per ha. This was due to the stocking rate of the two farmlets being kept the same while in the previously reported studies the stocking rate on the autumn farmlets was reduced. In the study reported by Spaans et al. (2019) the stocking rate was kept the same on both farmlets, but only homegrown pasture silage was fed as supplement. In their study they found that the autumn farmlet produced less milksolids per cow and per ha. However, in the present study, it was found that it is possible for an autumn farmlet to produce more milksolids per ha than a spring farmlet if higher amounts of supplements are fed, especially during the winter months when the pasture growth is low, and the autumn herd is at peak lactation. In addition, the type of supplements fed will also have an impact on milk production. A substantial amount of a PKE-based meal mixture was fed to the

autumn herd in the present study, providing a source of high protein and high energy feed, thereby positively impacting milk production and BCS.

The autumn herd had a significantly higher BCS than the spring herd at dry-off. This was due to a better alignment of the autumn cow's feed demand with the pasture growth curve and more high-quality pasture being available at the end of the lactation period for the autumn herd (December/January) than for the spring herd (March/April). It was therefore possible to milk the autumn herd longer, achieving more days in milk while still reaching target BCS before calving.

Previous studies have reported slightly lower submission rates and higher empty rates for autumn calving herds (Gracia and Holmes 1999). However, there are also studies where no significant difference was observed (Pacheco-Navarro 2000). In the present study, slightly higher empty rates (2 - 4%) were observed for the autumn herd. An autumn calving herd will be mating during winter (from around the 1<sup>st</sup> of June). It has been proposed that a combination of factors might affect the mating in wintertime, such as daylight hours, temperature, weather, and differences in energy balance (Garcia and Holmes 1999).

The gross farm revenue was 12 - 31% higher for the autumn farmlet due to the higher milk production and

the winter milk premium. The total operating expenses were also 9 – 19% higher for the autumn farmlet. The main difference in operating expenses was the cost of supplementary feed, due to the higher amounts required for the autumn farmlet. Despite the higher operating expenses, the autumn farmlet was found to have 16 – 59% higher operating profit. The higher milk production on the autumn farmlet in combination with the winter milk premium rendered the autumn farmlet more profitable. Overall, on average, over the three seasons of the trial, the autumn farmlet was found to be 33% more profitable than the spring farmlet. In the study performed by the Northland Dairy Development Trust (2000), it was found that the autumn calving farmlet was 21% more profitable than the spring farmlet over the three seasons of the trial. In the study reported by Spaans et al (2019), on the other hand, the spring farmlet was found to be more profitable. The main difference between the Spaans study and the present study was the quantity and type of supplements that were fed. This highlights the importance of both the amount and quality of supplements during winter milking to optimise milk production and maintain target BCS.

The largest difference in profitability between the two farmlets was found in the first season of the trial (59%), when the difference in milk production between the two herds was highest. The first season of the trial had a very dry summer and autumn (January – May 2020). The effect on the autumn herd was much smaller than on the spring herd, since the cows in the autumn herd were dry from late January to early March. High amounts of supplements had to be fed to the autumn herd once they had calved, but a high milk production was achieved as a result. In contrast, because of the dry conditions, the spring herd was only milked once a day from February and had to be dried off a month early, cutting milk production short. This indicates that a spring calving system is more susceptible to summer dry conditions, and the impact of a drought on milk production can be mitigated in an autumn calving system when dry conditions coincide with the end rather than the middle of lactation. In the second season substantially lower amounts of supplements were fed on the spring farmlet and the milk production increased due to more days in milk, giving a smaller difference in profitability between the two farmlets (23%). The autumn farmlet produced the lowest amount of milk in the third season. However, profitability was still 16% higher than on the spring farmlet. These results support the assumption that autumn calving might be best suited for areas that are dry in the summer months as this will be more limiting on a spring calving system than an autumn calving system (Chikazhe et al. 2017).

The profitability of the autumn farmlet was sensitive

to the winter milk premium. Without the winter milk premium, the autumn farmlet was still more profitable in the first two seasons of the trial (Season 1: 35%, Season 2: 5%) while in Season 3 the profitability was slightly less on the autumn farmlet (-0.4%). The lower profitability without the winter milk premium in the third season was due to lower milk production on the autumn farmlet and increased cost of supplements compared to the previous two seasons. A 50% reduction of the winter milk premium would still render the autumn farmlet more profitable in all three seasons.

The milk production, winter milk premium and cost of the supplements had the largest impact on the profitability of the autumn farmlet. The requirement for supplements was higher on the autumn farmlet and the cost associated with the supplements had to be offset by an increase in milk production. The profitability of an autumn calving system therefore depends on the milk price, the winter milk premium and the cost of the supplement. The higher requirement for bought in supplements on the autumn farmlet represents a risk in terms of availability and cost of the supplements.

A large proportion of the supplements fed to the autumn herd was a PKE-based meal mixture that was fed through an in-shed feeding system, which did not require extra labour. However, if the farm did not have an in-shed feeding system and the PKE-based meal mixture would have to be fed on a feed pad or in the paddocks, there would be an increase in farm working expenses (FWE) on the autumn farmlet due to increased labour hours and related costs such as fuel and repair and maintenance. A recently updated analysis by Northland Dairy Development Trust shows that the extra cost associated with every \$1 spent on supplements can increase FWE by up to \$0.95, effectively doubling the cost of supplement (Northland Dairy Development Trust 2021 and 2024).

Changing from a spring to an autumn calving system will also have implications on the lifestyle of the farmer. One of the benefits of the autumn calving system was that the cows were dried off by the end of January, giving the farm staff the opportunity to take time off during summer. The calving period of the autumn calving system was also during more favourable climatic conditions, with warmer temperatures, less rain and more daylight hours.

The biggest challenge with the autumn farmlet was milking cows during the winter months, which involved shorter daylight hours and harsher climatic conditions, including more rain, wind, and lower temperatures. The requirement for feeding supplements was also substantially higher on the autumn farmlet, especially during the winter months. If changing to an autumn calving system, the farmer must be prepared and have the necessary infrastructure to feed higher amounts of

supplements and manage milking during the winter months. It is also worth noting that New Zealand dairy and its supporting industries are set up around spring calving which can pose some extra challenges for an autumn calving system. Another consideration is the effect of summer conditions and heat stress during late pregnancy. Evidence from the US suggests there is an effect (Dahl et al. 2016), however this is unknown in pasture-based systems in New Zealand and Taranaki.

Lastly, the environmental impact needs to be taken into account when considering a change of system. Significantly higher amounts of imported supplement are required to achieve higher production in an autumn calving system. These supplements can elevate the farm's carbon footprint due to greenhouse gas (GHG) emissions associated with their production and use. Ledgard and Falconer (2015) reported carbon footprints of 0.506, 0.355 and 0.004 kg CO<sub>2</sub>-equivalent per kg DM for PKE, concentrates, and brewers grain, respectively. Given cost constraints and the need to maintain profitability, PKE will likely constitute the majority of the supplementary feed, thereby substantially increasing the farm's total GHG emissions. Management practices, other inputs such as fertiliser and the increase in per cow production while keeping stocking rate constant will all determine the carbon footprint of the milk produced and this will need to be calculated for the individual farm system.

## Conclusions

The calving system will have an impact on several aspects of the farming business. There was a higher demand for supplementary feed on the autumn farmlet due to the cows being milked through the winter months. The autumn herd produced more milksolids per cow and per ha and had more days in milk than the spring herd. There were no clear trends in difference in treated cases of mastitis and lameness between the two herds. The autumn herd had higher average BCS at dry off due to more high-quality pasture being available at the end of the lactation period, enabling an extension of the lactation period resulting in more days in milk. Empty rates were slightly higher for the autumn herd.

The autumn farmlet was found to be 33% more profitable on average than the spring farmlet over the three seasons of the trial. The difference in profitability was mainly due to higher milksolids production on the autumn farmlet and the winter milk premium.

The study indicates that it can be possible to increase the profitability of a farming business if changing the system from spring to autumn calving, especially in areas that are prone to dry summers.

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## REFERENCES

- Babylon, A, Woodward S, Beukes, P. 2023. Summer growth rates and annual yields of perennial ryegrass (*Lolium perenne* L.) in the Upper North Island are expected to decline as a result of climate change. *Journal of New Zealand Grasslands* 84: 31-40. <https://doi.org/10.33584/jnzs.2022.84.3565>
- Chikazhe TL, Mashlan KA, Beukes PC, Glassey CB, Haultain J, Neal MB. 2017. The implications of winter milk premiums for sustainable profitability of dairy systems. *Journal of New Zealand Grasslands* 79: 43-48. <https://doi.org/10.33584/jnzs.2017.79.557>
- Dahl GE, Tao S, Monteiro APA. 2016. Effects of late-gestation heat stress on immunity and performance of calves. *Journal of Dairy Science* 99 (4):3193-3198. <https://doi.org/10.3168/jds.2015-9990>
- Garcia SC, Holmes CW. 1999. Effects of time of calving on the productivity of pasture-based dairy systems: A review. *New Zealand Journal of Agricultural Research* 42: 347-362. <https://doi.org/10.1080/00288233.1999.9513384>
- Garcia SC, Holmes CW, McDonald A, Lundman M, Lundman J, Pacheco-Navarro R. 2000. Comparative efficiency of autumn and spring calving for pasture-based dairy systems. *Asian Australasian Journal of Animal Sciences* 13: 533-537.
- Garcia SC, Holmes CW. 2001. Lactation curves of autumn- and spring-calved cows in pasture-based dairy systems. *Livestock Production Science* 68: 189-203. [https://doi.org/10.1016/S0301-6226\(00\)00237-2](https://doi.org/10.1016/S0301-6226(00)00237-2)
- Jarman JWM. 2020a. *Biophysical implications and economic considerations when changing from spring to autumn calving in pasture-based dairy systems*. Master thesis. Massey University, Manawatu, New Zealand. 203 p.
- Jarman JWM, Kay JK, Neal M, Donaghy D, Tozer P. 2020b. Implications of using an extended lactation to change from a spring-calving to an autumn-calving farm system in South Taranaki. *New Zealand Journal of Animal Science and Production* 80: 143-149.
- Ledgard S, Falconer S. 2015. *Total greenhouse gas emissions from farm systems with increasing use of supplementary feeds across different regions of New Zealand* [SLMACC Milestone Report]. AgResearch. 70 p.

- <https://mpi.govt.nz/dmsdocument/28329-total-greenhouse-gas-emissions-from-farm-systems-with-increasing-use-of-supplementary-feeds-across-different-regions-of-new-zealand/>
- MacDonald KA, Penno JW. 1998. Management decision rules to optimize milk solids production on dairy farms. *Proceedings of the New Zealand Society of Animal Production* 58: 132-135.
- Northland Dairy Development Trust. 2000. <https://nddt.nz/wp-content/uploads/split-calving-detail.pdf>
- Northland Dairy Development Trust. 2021. [3-yr-Summary-Lessons-Learnt-June-21.pdf](https://nddt.nz/wp-content/uploads/3-yr-summary-lessons-learnt-june-21.pdf)
- Northland Dairy Development Trust. 2024. [Factors-affecting-profitability-of-Supplement-Use.pdf](https://nddt.nz/wp-content/uploads/factors-affecting-profitability-of-supplement-use.pdf)
- Pacheco-Navarro RA. 2000. *Reproductive efficiency in dairy cattle calving during autumn or spring*. Master thesis. Massey University, Manawatu, New Zealand. 164 p.
- R Core Team. 2024. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. <https://www.R-project.org/>
- Roche JR, Friggens NC, Kay JK, Fisher MW, Stafford KJ, Berry DP. 2009. Invited review: Body condition score and its association with dairy cow productivity, health, and welfare. *Journal of Dairy Science* 92: 5769-5801. <https://doi.org/10.3168/jds.2009-2431>
- Spaans OK, Macdonald KA, Neal M, Auldism M, Lancaster JAS, Bryant AM, Doole GJ, Roche JR. 2019. A quantitative case study assessment of biophysical and economic effects from altering season of calving in temperate pasture-based dairy systems. *Journal of Dairy Science* 102: 11523-11535. <https://doi.org/10.3168/jds.2018-15911>
- Tait AB, Renwick JA, Stroombergen, AH. 2005. The economic implications of climate-induced variations in milk production. *New Zealand Journal of Agricultural Research* 48: 213-225. <https://doi.org/10.1080/00288233.2005.9513651>