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Comparative study of first lactation performance of Norwegian Red crossbred cows with traditional breeds in New Zealand dairy systems

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ABSTRACT

Some New Zealand dairy farmers are using semen from Norwegian Red (NR) bulls to explore the performance of this breed under local grazing conditions. The objective of this study was to compare the first lactation performance of first cross NR cattle with traditional New Zealand breeds. Data were collected from six dairy farms in Southland, New Zealand, during 2022–2023 milk production seasons. Data were collected from 1178 first lactation cows including herd test of daily yields of milk, fat and protein and somatic cell counts, and persistency. Breeds included 386 NR cross (NRX), 231 Holstein Friesian (F), 84 Holstein Friesian cross (FX), 134 Holstein Friesian x Jersey (FJ) and 58 Jersey cross (JX) cows. Findings indicate F cows produced the greatest cumulative milk yield (3,744 kg), 138.6 kg more than NRX cows. There were no significant differences among the breed groups for milk yield and milk solids yield persistency and SCS (SCS = Log_2 SCC). The total lactation milk yield of NRX cows was lower than that of the other breeds, excluding JX. These results pertain specifically to first lactation cows; therefore, it is necessary to undertake further analysis to evaluate the long-term productivity and longevity of NR breeds under New Zealand conditions.

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Introduction

The New Zealand dairy system is predominantly pasture-based, which requires a compact calving in spring, and robust animals to efficiently produce milk from pasture. Since the 1990s, the breed composition of the national herd has shifted significantly, favouring crossbred Holstein Friesian (F) and Jersey (J) (F × J) cows (LIC & Dairy NZ 2023). The New Zealand dairy industry has adapted and prospered with the rise of crossbred dairy cows, and 59.9% of the 2023 national dairy herd consists of F × J (LIC & Dairy NZ 2023). The popularity of F × J cows is attributed to the exploitation of heterosis, which has produced animals with greater fertility, productivity and survival, therefore greater profit (Harris 2005).

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Some farmers have begun incorporating a Nordic breed, the Norwegian Red (NR) into a three-way crossbreeding programme. The NR is claimed to have superior health traits, having been selectively bred for resistance to mastitis and improved fertility traits (McClearn et al. 2020). The NR breed is a result of a breeding programme with three different breeds: Finnish Ayrshire, Swedish Red and Danish Red. The Nordic breeding objective has had a heavy focus on health and fertility traits since the 1970s, unlike in New Zealand where the focus was purely on production until 1995, when liveweight, somatic cell score, fertility and survival were included in the selection index (Harris 2005). The NR breeding goal has a 24% weighting on milk production, 22% on mastitis resistance and 15% on fertility, which indicates an emphasis on health traits, (Steine et al. 2008). Begley et al. (2010) compared the incidence of clinical mastitis in F, NR and NR × F, showing that the frequency of mastitis over one lactation was 12% in F, 6% in NR and 10% in NR × F. A study was undertaken by McClearn et al. (2020) to assess production traits of the F, F × J and a three-way-cross NRX. Results indicated that lactation length was comparable across all breeds, with J × F having the longest at 285 days and NRX being the shortest at 280 days. The total milk yield was significantly greater in the F (5,720 kg/cow), than either J × F (5,446 kg/cow) or NRX (5,366 kg/cow). The fat and protein content of J × F and three-way cross were similar: protein content was 3.87% for J × F and 3.88% for the three-way cross, and fat content was 4.86% for J × F and 4.75% for the three-way cross (McClearn et al. 2020). Lopez-Villalobos et al. (2000) proposed that a three-breed rotational breeding system could increase profitability in New Zealand pasture-based systems. The incorporation of NR into the New Zealand dairy population remains unexplored. For any breed to be included in a three-way cross in New Zealand, it must be economically viable and maintain current production levels. Additionally, it should enhance robustness traits in dairy cows, providing overall benefits to the herd.

The objective of this study, therefore, was to compare the first lactation performance of F_1 NR cows with traditional breeds within the New Zealand dairy production system, investigating milk yield, fat yield, protein yield, somatic cell score and lactation persistency. These comparison points are critical indicators of the milk quality and productivity of a dairy cow in New Zealand.

Material and methods

Data

The data set was obtained from the MINDA® (https://www.lic.co.nz/products-and-services/minda/), database of the Livestock Improvement Corporation (LIC), New Zealand. The data set included 3,559 herd test records obtained from 1178 primiparous dairy cows from six spring calving dairy farms in Southland during the 2022–2023 season. Breed groups were derived from animals' breed composition and expressed as a fraction of 16. There were 231 F, 84 Holstein Friesian crossbred (FX), 58 Jersey crossbred (JX), 134 F by J (FJ) crossbred and 386 F_1 Norwegian Red crossbred (NRX) cows. Only records from these breeds were included, and records pertaining to other breeds or animals with missing breed identification were excluded.

Individuals' milk yields were recorded via herd tests, conducted four times throughout the season. Animals needed to have a minimum of three recorded herd tests to be

included in the analysis. Individual herd tests were for daily milk, fat and protein yields and somatic cell count (SCC), and accumulative yields of milk (MY), fat (FY), and protein (PY). An average of somatic cell score (SCS) during the lactation for each cow was derived from the SCC herd tests, where SCS was calculated as $SCS = Log_2 SCC$.

Persistency

Lactation curves for each cow were modelled using random regression with a third-order orthogonal polynomial by the method in Lembeye et al. (2016). Persistency (P) was defined as the ability of a cow to maintain production after peak yield is reached. Using predicted daily yields for milk and milksolids (FY + PY), the cumulative estimated yield from day 1 to 90 (A) and from day 181 to 270 (C), a measure of persistency was calculated as,

$$P = \frac{C}{A} \times 100$$

Larger values of P indicate greater lactation persistency.

Statistical analysis

Analysis of variance for lactation length, MY, FY, PY, and average SCS were tested using a mixed model analysis using the PROC MIXED procedure in SAS version 9.4 software (SAS Institute Inc, Cary NC, USA). The model included the fixed effects of herd and breed group, and random residuals. Results are presented as least squares means and standard errors of the mean. Least squares means for breed groups were used for multiple means comparisons using Fisher's least significant difference test.

Results

Total yields

Table 1 presents descriptive statistics of traits analysed in this study and Table 2 presents the least squares means for milk production traits and persistency for the different breed groups. The average lactation length was 240 days with a standard deviation of 16 days.

Table 1. Descriptive statistics for lactation length, total yields for milk, fat, protein and milksolids (fat plus protein), persistency of milk and milksolids, and somatic cell score in primiparous cows from five genetic groups.

	Mean	SD	CV (%)	Minimum	Maximum
Lactation length (d)	240	16	7	155	268
Total yields (kg/cow)					
Milk	3,608	718	20	1228	6124
Fat	167	34	20	42	292
Protein	143	27	19	44	237
Persistency[1] (%)					
Milk	60	10	17	31	117
Milksolids	71	11	15	43	167
Somatic cell score	5.683	1.470	26	1.584	12.931

[1]Persistency was calculated as $P = (C/A) \times 100$, where A is the accumulative yield from day 1 to 90 and C is the cumulative yield from day 181 to 270.

Table 2. Least squares means and standard errors for lactation length, total yields for milk, fat, protein, persistency of milk and milksolids, and somatic cell score in primiparous cows of Friesian, Friesian cross, Friesian x Jersey, Jersey cross and Norwegian Red cross breeds.

	Friesian	Friesian cross	Friesian × Jersey	Jersey cross	Norwegian Red cross	*P* Value
No. of cows	231	134	84	58	386	
Lactation length (d)	$244^{b} \pm 1$	$242^{b} \pm 2$	$248^{a} \pm 2$	$248^{a} \pm 2$	$242^{b} \pm 1$	<0.0001
Total yield (kg/cow)						
Milk	$3{,}743^{a} \pm 51$	$3{,}673^{b} \pm 61$	$3{,}689^{ab} \pm 77$	$3{,}537^{c} \pm 95$	$3{,}605^{bc} \pm 38$	<0.0001
Fat	$168^{b} \pm 2$	$168^{b} \pm 2$	$177^{a} \pm 3$	$184^{a} \pm 4$	$163^{b} \pm 1$	<0.0001
Protein	$148^{a} \pm 2$	$146^{a} \pm 2$	$149^{a} \pm 2$	$149^{a} \pm 3$	$140^{b} \pm 1$	<0.0001
Persistency (%)						
Milk	60 ± 1	58 ± 1	59 ± 1	56 ± 1	61 ± 1	0.0833
Milk solid	71 ± 1	70 ± 1	73 ± 1	73 ± 2	73 ± 2	0.2558
Somatic cell score (cells/ml)	5.619 ± 0.10	5.791 ± 0.13	5.698 ± 0.16	6.075 ± 0.19	5.620 ± 0.08	0.3098

[a,b,c]Least squares means with different superscripts in each column are significantly different ($P < 0.05$).

Significant differences were observed across all breed groups for all total yield variables ($P < 0.0001$). Lactation length varied between breeds ($P < 0.0001$), with the FJ and JX cows having the longest lactation of 248 ± 2 days, compared to the F (244 ± 1 days), FX (242 ± 2 days) and NRX (242 ± 1 d) cows. The average total MY was 3608 kg, with a standard deviation of 718 kg; the F had a significantly ($P < 0.05$) greater MY, followed by FX, NRX and J. Total FY average was 167 kg, with a standard deviation of 34 kg; JX and FJ cows had significantly ($P < 0.05$) greater FY than F, FX and NRX cows. The average total PY was 143 kg with a standard deviation of 27 kg. The protein yield in NRX cows was significantly ($P < 0.0001$) lower compared to that of the other four genetic groups.

Persistency

Overall persistency is shown in Table 1 and persistency by breed is given in Table 2. The overall average for persistency of milk yield was 60% (SD = 10%). There were no significant differences among breed groups for persistency for both MY ($P = 0.0833$) and MSY ($P = 0.2558$).

Somatic cell count

Overall, SCS (cells/ml) is shown in Table 1 and SCS by breed is given in Table 2. The average SCS was 5.683 (SD = 1.47), and there was no overall significant difference among the breeds ($P = 0.3098$).

Discussion

Significant differences were observed in the milk production across the different genetic groups. The F cows exhibited the greatest total MY, and the JX cows showed the greatest FY. This can be attributed to the greater genetic merit for MY in F cows and for FY in JX cows compared to cows from the other breed groups (Harris 2005). Previous studies by Hickson et al. (2006) indicated that F cows produced the greatest total MY, and Lembeye et al. (2016) reported that FJ cows had a greater total FY and PY compared to J cows. Limited studies have compared the NRX with F or J for milk production under grazing conditions, as presented in this study.

In the current study, NRX cows had the lowest total PY and FY and the second lowest MY.

Ferris et al. (2018) compared HF cows to Swedish Red × J × F cows in pasture-based systems in Northern Ireland. The study reported that F cows had greater MY, but MSY was similar between the two groups. McClearn et al. (2020) studied HF, J × HF and NR × (J × HF) cows over three lactations in Ireland and reported that HF cows had the greatest MY during the first lactation, while J × HF cows had the greatest PY and FY. The trends in MY, FY and PY remained consistent across the subsequent lactations. The findings of the current study align with those reported by McClearn et al. (2020) that NRX does not produce a greater MY compared to F, neither do they exhibit a greater MSY than J.

Lembeye et al. (2016) reported that J cows exhibited the greatest persistency for MSY compared with F and FJ cows, and FJ cows had the greatest persistency for MY compared to F and J. In the current study, there was no significant difference in MY or PY persistency across all breed groups. High persistency cows are more likely to experience adverse outcomes associated with asynchronous lactation and pasture availability. Cows with greater persistency have increased energy requirements due to greater yields being maintained throughout the season. Energy available from pasture declines as the season progresses; this may result in a mismatch of energy requirements and feed availability, which can lead to decreased milk production and negatively impact the overall health of animals (López-Villalobos et al. 2005). Conversely, cows with lower persistency are not fully utilising the available pasture for production. As inputs fluctuate throughout the season, maintaining a consistent level of persistency across the herd is essential.

Increased levels of SCC in milk indicate an immune response to mastitis which is the inflammation of the udder, often caused by bacteria infection or trauma to the udder. In the current study, F, FX, and NRX cows did not have significantly lower SCS compared to FJ cows. Begley et al. (2010) reported that NRX cows had a reduced frequency of clinical mastitis compared to F cows. McClearn et al. (2020) found no significant difference in the SCC of NRX, J, and F between breed groups. Although Buckley et al. (2014) noted that crossbreeding with NR produced more robust cows, the small variance in SCC across breed groups observed in this study contrasts with these reports, as the NRX was not significantly different to the other breed groups. In future studies, recording of individual cows' clinical mastitis cases may give a better insight into mastitis frequency in the NRX, compared to the method used in this study of SCS. Other studies have shown there is potential to improve health traits of traditional dairy breeds with the use of NR bulls.

The NRX was found to have lower MY, FY and PY in comparison to the other breed groups in this study. As these results only pertain to first lactation animals, further analysis is required to understand the long-term suitability and productivity of NR dairy cattle in New Zealand. Further studies should be undertaken regarding survivability, fertility, udder confirmation, incidence of clinical mastitis and overall economic analysis of NR breed under New Zealand dairy conditions.

Conclusion

The results of this study revealed differences in cumulative milk production among F, FX, FJ, JX and NRX cows during their first lactation. Overall, the F and FJ cows exhibited

greater MY. The JX and FJ showed the greatest FY, and F, FX and FJ and JX had the greatest PY compared to NRX cows. Persistency for MY and MSY, and SCS were not significantly different across breed groups. This research aimed to provide insight into the Norwegian Red breed's performance under New Zealand dairy farming conditions. The Norwegian Red is known for its robustness and resilience traits, which are important in pasture-based systems, where the aim is to efficiently convert pasture into production. Further research is needed to evaluate the long-term viability and performance of NRX cows in New Zealand dairy production systems.

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Disclosure statement

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

References

Begley N, Buckley F, Pierce KM, Evans R. 2010. Breed difference and heterosis estimates for milk production and udder health among Holstein, Friesian and Norwegian Red dairy cattle. Advances in Animal Biosciences. 1:341–341. doi:10.1017/S204047001000484X.

Buckley F, Lopez-Villalobos N, Heins BJ. 2014. Crossbreeding: implications for dairy cow fertility and survival. animal. 8(s1):122–133. doi:10.1017/S1751731114000901.

Dairy Z, & LIC. 2023. New Zealand Dairy Statistics: 2022-23.

Ferris CP, Purcell PJ, Gordon AW, Larsen T, Vestergaard M. 2018. Performance of Holstein and Swedish-Red × Jersey/Holstein crossbred dairy cows within low- and medium-concentrate grassland-based systems. Journal of Dairy Science. 101:7258–7273. doi:10.3168/jds.2017-14107.

Harris BL. 2005. Breeding dairy cows for the future in New Zealand. New Zealand Veterinary Journal. 53:384–389. doi:10.1080/00480169.2005.36582.

Hickson RE, Lopez-Villalobos N, Dalley DE, Clark DA, Holmes CW. 2006. Yields and persistency of lactation in Friesian and jersey cows milked once daily. Journal of Dairy Science. 89:2017–2024. doi:10.3168/jds.S0022-0302(06)72269-X.

Lembeye F, López-Villalobos N, Burke JL, Davis SR, Richardson J, Sneddon NW, Donaghy DJ. 2016. Comparative performance in Holstein-Friesian, Jersey and crossbred cows milked once daily under a pasture-based system in New Zealand. New Zealand Journal of Agricultural Research. 59:351–362. doi:10.1080/00288233.2016.1207669.

Lopez-Villalobos N, Garrick DJ, Holmes CW, Blair HT, Spelman RJ. 2000. Profitabilities of some mating systems for dairy herds in New Zealand. Journal of Dairy Science. 83:144–153. doi:10.3168/jds.S0022-0302(00)74865-X.

Lopez-Villalobos N, McNaughton LR, Spelman RJ. 2005. The relationship between lactation persistency and reproductive performance in New Zealand dairy cattle. Proceedings of the 56th Annual Meeting of the EAAP; Uppsala, Sweden.

McClearn B, Delaby L, Gilliland TJ, Guy C, Dineen M, Coughlan F, Buckley F, McCarthy B. 2020. An assessment of the production, reproduction, and functional traits of Holstein-Friesian, Jersey × Holstein-Friesian, and Norwegian Red × (Jersey × Holstein-Friesian) cows in pasture-based systems. Journal of Dairy Science. 103:5200–5214. doi:10.3168/jds.2019-17476.

Steine G, Kristofersson D, Guttormsen AG. 2008. Economic evaluation of the breeding goal for Norwegian Red dairy cattle. Journal of Dairy Science. 91:418–426. doi:10.3168/jds.2006-747.