Mitigation of heat stress now and in future and the role of veterinarians

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Background

Heat stress in dairy cows is of increasing concern domestically and internationally due to impacts on cow welfare and public acceptance of dairying. Excessive heat can negatively impact cow productivity, health, reproduction, and welfare, and under extreme conditions can cause suffering, or death. It has been estimated that globally, the cost of heat stress could reach $30 billion USD by 2050 if unmitigated (Allen 2023), and therefore, heat stress is a significant challenge. DairyNZ recently identified that despite our predominantly pasture-based dairy systems providing benefits for dairy cow health and welfare (e.g. freedom of movement, lower risk of disease) with opportunities to express natural behaviours (e.g. grazing and exploration), there are also risks to cow quality of life where cows are outdoors year-round and exposed to climatic extremes (Hendriks *et al.* 2025b). In a survey across 222 New Zealand farms, 68% and 16% of farms scored moderate and high risk for heat stress, respectively, during summer. This indicates that cows may have limited opportunities to seek effective shade, replenish evaporative water loss, or reduce their heat load through other means (e.g. sprinklers, fans, reduced walking distance or milking frequency) (Hendriks *et al.* 2025b). Alongside downstream impacts of unmitigated heat load on dry matter intake and milk production, being unable to express heat-abating behaviours could lead to negative mental affects. Our aim is to provide farmers in high-risk regions with practical information to support tactical and strategic decisions to maintain cow comfort and performance in heat stress conditions. Thus, it is important to understand current on-farm practices relating to heat stress mitigation to identify where there are opportunities and limitations to provide resources or adapt management to reduce heat stress risk. It is crucial to understand both the current and future mitigation options available to farmers to support their adoption. Veterinarians are important stakeholders within the dairy industry and are ideally placed to support the implementation of on-farm mitigation strategies that safeguard the health and welfare of dairy cows. In this paper we summarise current short- and long-term mitigation strategies available to farmers for managing heat stress on farm and present data regarding the adoption of a range of mitigation strategies on New Zealand dairy farms.

Materials and methods

First, we undertook a narrative review to summarise current short- and long-term mitigation strategies for farmers and identify research opportunities for existing and novel mitigations in New Zealand, where cows are managed outdoors on pasture. In this paper, we highlight the key findings from our review that were published elsewhere (Hendriks *et al.* 2025a). Second, we summarised data from a DairyNZ database containing survey responses from farmers who were asked questions relating to heat stress from 2019 to 2023. A full description of this database and how the data were obtained is provided by Timmer-Arends and Hendriks (2024). Briefly, we extracted data for the key survey questions relating to heat stress from DairyNZ's cloud database storage (Snowflake, Snowflake Inc., MO, US), and aggregated and visualised these data using R software (version 4.2.2: R Core Team 2022, Vienna, Austria).

In total, data were available from 1,475 farms collected from November to March during five different seasons (2019 to 2023). The year refers to the start of the dairy season, with questions capturing data for that entire season through to 31 May, i.e. 2019 refers to the dairy season 1 June 2019 to 31 May 2020 and the farmers were surveyed between November 2020 and March 2021. Each survey year a different cohort of farms was surveyed, and therefore, the data doesn't represent longitudinal data but provides a general overview of on-farm practices within each cohort and survey year. Further, in each survey year, apart from 2021 where Northland farms were excluded due to Covid-19 restrictions, the farm recruitment captured a population of farms representative of the distribution of dairy farms across New Zealand. Care should be taken when extrapolating regional results as the data were collected by different contractors within region, and therefore, assessor bias cannot be ruled out.

Results and discussion

Across all survey years, mean peak cows milked [± standard deviation (SD)] was 404 ± 21 cows, with milk solids production of 402 ± 8.4kg per cow. The mean proportion of farms represented across all survey years was 7.8% for Northland, 27.5% for Waikato, 10.5% Bay of Plenty, 13.9% Taranaki, 7.8% Lower North Island, 4.8% Top of the South/West Coast, 17.4% Canterbury/North Otago, and 11.8% Southland/South Otago.

Current on-farm practices

Water

Farmers were asked if they have water troughs available at the dairy or in races. On average, 66 ± 2.7% of farmers (mean ± SD) indicated that they provided water troughs at the milking shed or in races, and this has remained consistent over five years (2019 to 2023). Providing more accessible and reliable water points of sufficient quality during summer was highlighted as an easily implementable solution to help cows reduce their head load by Hendriks *et al.* (2025b).

Shade

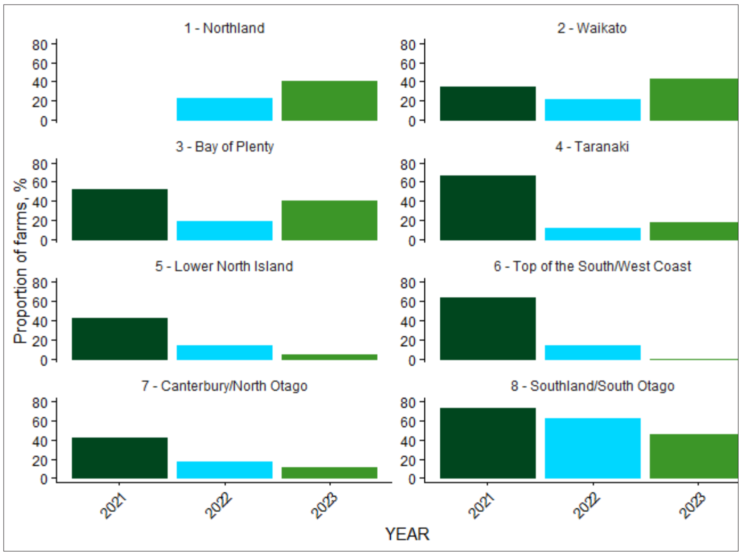
Since 2021, we have asked farmers if they feel they have enough shade for their herd and this has declined over three years where 49% (n = 107/219), 23% (n = 52/222) and 28% (n = 70/250) of farms indicated they felt they had adequate shade available for all of their cows in 2021, 2022, and 2023, respectively. This may reflect increasing awareness of thermal stress or that the impacts of climate change are beginning to be felt on farms.

Across regions, this trend is more evident in the Lower North Island, Top of the South/West Coast, Canterbury/North Otago, and Southland/South Otago regions (Figure 1). Recent modelling indicates that dairy cows are at risk of heat stress annually for 37 to 80 days in New Zealand with greater risks predicted in the Waikato (69 days), Bay of Plenty (69 days) and Canterbury (80 days) regions in the 2020s (Woodward *et al.* 2025).

Based on climate projections to the 2050s, these regions will experience the greatest increases in heat stress risk. For the 2020s, moderate heat stress risk is expected in Northland (51 days), West Coast (52 days), East Coast (49 days), and the Manawatu (47 days) with the lowest number of heat stress risk days predicted in Taranaki (38 days) and Otago-Southland (37 days). Hitchman *et al.* (2024) found solar radiation is a more important driver of heat load than humidity under grazing conditions; exposure to coastal wind can have a cooling effect, therefore, some typically warmers regions such as Northland may be benefiting from this.

Given there are heat risks across all regions, it is important to understand what options farmers currently have available to support the minimisation of heat stress risk. While a grazing head load index has been developed for use under New Zealand's pasture-based conditions for predicting heat stress conditions, further research is required to improve its predictive ability and embed it into a forecasting tool (Hitchman *et al.* 2024).

Figure 1. The proportion of farms that indicated that they had adequate shade on their farms across eight New Zealand regions and three survey years (2021 to 2023).



Resources and facilities to reduce heat stress

Farmers were asked what resources and facilities they have available to reduce heat stress. A range of options were reported but the most common are shelter belts and trees in paddocks and sprinklers (Table 1). We are unable to discern from the information provided whether the options available provide opportunities to mitigate heat load effectively, particularly those that are only effective if they provide shade during the hottest parts of the day.

Table 1. Mean ± standard deviation (SD) proportion of farms using a range of resources and facilities to manage heat stress across 1,475 farms surveyed across eight New Zealand regions and five seasons (2019-2013).

	Proportion of farms surveyed (%)
Strategy	Mean ± SD
Shelter belts	49.5 ± 5.44%
Stand of trees in paddock	31.1 ± 3.42%
Sprinklers	34.6 ± 3.11%
Barn/shed/covered standoff	7.30 ± 1.93%
Misters	6.36 ± 1.94%
Fans	3.68 ± 0.76%
Shade over yard	1.86 ± 0.91%

On a regional level, the proportions of farms with shade-based mitigation options available in paddocks varied widely but were highest in Northland, Bay of Plenty, and Top of the South/West Coast regions and lowest in Taranaki and Canterbury/North Otago regions (Table 2). Providing shade is important to allow cows to engage in shade-seeking behaviour although could be more complex in large herds (Schütz *et al.* 2008), particularly on farms with centre-pivot irrigation crossing most of the farmed area. The Canterbury region has the largest area of irrigated agricultural land in New Zealand and is at the greatest risk for heat stress according to Woodward et al. (2025), demonstrating regional challenges that will require localised solutions to address heat stress.

Table 2. Mean ± standard deviation (SD) proportion of farms with stands of trees, shelter belts or barn/sheds available to provide shade across 1,475 farms surveyed in eight regions of New Zealand and five seasons (2019-2013).

Region	Shelter belts	Stand of trees in paddock	Barn/shed/covered standoff
Northland	38.8 ± 15.0%	82.2 ± 12.3%	3.25 ± 2.39%
Waikato	19.3 ± 2.62%	68.0 ± 13.3%	1.82 ± 1.87%
Bay of Plenty	37.5 ± 9.87%	72.7 ± 12.6%	3.96 ± 6.51%
Taranaki	74.4 ± 12.3%	18.2 ± 5.26%	0.32 ± 0.72%
Lower North Island	68.8 ± 26.9%	61.3 ± 3.96%	2.86 ± 6.40%
Top of the South/West Coast	45.1 ± 25.2%	71.7 ± 15.0%	3.08 ± 4.39%
Canterbury/North Otago	67.5 ± 13.1%	17.7 ± 5.51%	0.76 ± 1.06%
Southland/South Otago	80.3 ± 11.3%	30.2 ± 11.5%	3.14 ± 3.86%

Management practices to reduce heat stress

Farmers reported a range of management strategies they use to reduce heat stress. The most common are once-a-day milking, altering milking times, reducing the walking distance, and wetting the cowshed yard or roof (Table 3).

Table 3. Mean ± standard deviation (SD) proportion of farms using a range of management strategies to manage heat stress across 1,475 farms surveyed in eight regions of New Zealand and five seasons (2019-2013).

	Proportion of farms surveyed (%)
Strategy	Mean ± SD
Reducing walking distance	36.0 ± 5.55%
Wet cowshed yard or roof	33.4 ± 2.97%
OAD milking	27.0 ± 3.73%
Altered milking times	24.6 ± 3.39%
Reducing milking frequency (i.e. 2-in-3 or other)	10.5 ± 2.90%

On a regional level, the proportions of farms using each management strategy to mitigate heat stress varied widely (Table 4). Once-a-day milking was used as a management strategy to manage heat stress by over a third of the farms surveyed in Northland, Waikato and Bay of Plenty while less than 10% of farms in Canterbury/North Otago and Southland//South Otago used this strategy. By contrast, other types of reduced milking frequency (e.g. 2-in-3 or other) was more common in these regions. Altered milking times and reducing the walking distance were relatively consistent across regions. Further, wetting the cowshed yard or roof was relatively widespread across regions, although slightly less common in the Top of the South/West Coast.

Table 4. Mean ± standard deviation (SD) proportion of farms using a range of management strategies to manage heat stress across 1,475 farms surveyed in eight regions of New Zealand and five seasons (2019 to 2023).

Region	Altered milking times	OAD milking	Reduced milking frequency (2-in-3 or other)	Reducing walking distance	Wet cowshed yard or roof
Northland	17.6 ± 9.85%	48.9 ± 15.6%	3.25 ± 2.39%	35.8 ± 13.4%	32.1 ± 26.5%
Waikato	23.0 ± 6.65%	42.8 ± 10.9%	8.50 ± 2.17%	37.8 ± 6.00%	34.8 ± 15.0%
Bay of Plenty	25.7 ± 13.0%	34.0 ± 4.94%	7.02 ± 6.89%	40.4 ± 12.2%	44.7 ± 17.4%
Taranaki	32.9 ± 6.60%	20.5 ± 8.18%	6.68 ± 3.11%	33.0 ± 9.10%	26.5 ± 9.09%
Lower North Island	27.1 ± 17.7%	40.0 ± 22.3%	0.52 ± 1.16%	43.3 ± 16.3%	35.9 ± 27.4%
Top of the South/West Coast	31.1 ± 27.2%	28.0 ± 9.98%	25.9 ± 21.0%	43.1 ± 28.3%	15.0 ± 10.2%
Canterbury/North Otago	16.9 ± 6.33%	4.26 ± 4.39%	17.9 ± 9.52%	20.8 ± 5.27%	34.4 ± 5.48%
Southland/South Otago	29.9 ± 24.5%	8.68 ± 8.04%	12.2 ± 5.60%	54.6 ± 31.6%	35.1 ± 17.7%

Mitigation strategies

New Zealand dairy farmers are already implementing many of the well-known short- and long-term mitigation strategies currently available (Tables 1 and 3); however, the effectiveness of these mitigations is difficult to determine from our data. Furthermore, it is challenging to predict when to implement mitigation strategies, which is a risk to dairy cow productivity and welfare, particularly in high-risk regions. Nevertheless, cows can begin to display signs of increased heat load at temperatures as low as 20°C and farmers can look for signs that indicate an increased risk of heat stress such as breathing faster or panting, grazing less, drinking more, walking slowly to and from the shed, and less milk in the vat (DairyNZ 2025). When visible signs of heat stress are evident it is important to provide options for cows to mitigate heat load. Veterinarians are recognised as highly trusted advisers and are well-positioned to help farmers recognise the signs of heat stress and explore the mitigation options available. Several resources and tools are available on DairyNZ (DairyNZ 2025) and Fonterra websites (Fonterra, 2025) for managing heat stress.

Actions that farmers can readily implement include the provision of additional water points, access to shade or sprinklers in the holding yard before milking, altering paddock grazing order to provide the herd with existing shade access, altering milking frequency (e.g. once a day), or timing of milking or feeding to avoid the hottest time of the day. Through our review we also identified options that are currently available but require a greater effort or lead-in time to implement, or options that may be available in future (Hendriks *et al.* 2025). These include modification of the physical environment by providing shade or planting trees and nutritional management using feed additives or alternative forage species. These mitigations require further research as several knowledge gaps exist regarding whether they are effective in mitigating excessive heat load while meeting the cows' biological, behavioural, and mental needs. Farmers should utilise proven mitigation strategies to support thermal comfort in dairy cows outdoors, while research into novel mitigation options continues.

Conclusion

Heat stress can impact cows' productivity, health, reproduction, and welfare. Therefore, under pasture-based dairy systems where cows are outdoors and exposed to hot conditions, it is important that farmers have options available to reduce cows' heat load. New Zealand dairy farmers are already implementing a range of management strategies and have resources available to manage heat stress risk; however, it is difficult to determine from our data whether these mitigation strategies are being implemented at the right time and are effective. Veterinarians are recognised as highly trusted advisers. When discussing preventative health, they can ensure that farmers know the signs of heat stress as well as the mitigation options available to support their cows to cope under hot conditions. Several resources and tools are available on the DairyNZ (DairyNZ 2025) and Fonterra websites (Fonterra 2025) for managing heat stress. More research is needed to forecast when heat stress events are likely to occur so that farmers can be better informed as to when to implement effective mitigation strategies.

Acknowledgements

We thank the surveyors who undertook animal care consultations, and the farmers interviewed. This research was funded by New Zealand dairy farmers through DairyNZ Inc., contract CRS6178 (Animal Care).

References

Allen K. Heat stress is a worldwide concern. *Hoards Dairyman,* 2023

DairyNZ. Heat stress. DairyNZ; 2025

Fonterra. Managing environmental stress. *NZ Farm Source.* New Zealand; 2025

Hendriks SJ, Edwards JP, Shirley AK, Clark CEF, Schütz KE, Verhoek KJ, Jago JG. Heat stress amelioration for pasture-based dairy cattle: Challenges and opportunities. *Animal Frontiers (accepted)*, 2025a

Hendriks SJ, Saunders K, DeWitt K, Timmer-Arends P, Jago J. The development of a tool to assess cow quality of life based on system-level attributes across pastoral dairy farms. *Animal* 101429, 2025b

Hitchman S, Zobel G, Schütz KE, Jago JG, Reed C, Hay E, Thomas C, Edwards JP, Verhoek KJ. Updated method of estimating heat load for grazing dairy cattle. *New Zealand Journal of Agricultural Research* 2024

Schütz KE, Cox NR, Matthews LR. How important is shade to dairy cattle? Choice between shade or lying following different levels of lying deprivation. *Applied Animal Behaviour Science* 114: 307–318, 2008
Timmer-Arends P, Hendriks SJ. Animal care practices on Aotearoa dairy farms. P*roceedings of the Dairy Cattle Veterinarians Branch of the 2024 NZVA & NZVNA Conference,* 2024
Woodward SJR, Beukes PC, Edwards JP, Verhoek KJ, Jago JG, Zammit C. Regional heat stress maps for grazing dairy cows in New Zealand under climate change. *Animal Production Science* 65: AN24231, 2025