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Shade impact on welfare of dairy cattle grazing in temperate climates: a rapid systematic review

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ADMINISTRATIVE INFORMATION

Support - Universidad Autónoma Chapingo and Consejo Nacional de Ciencia y Tecnología (CONACyT).

Review Stage at time of this submission - Formal screening of search results against eligibility criteria.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY202630011

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 3 March 2026 and was last updated on 3 March 2026.

INTRODUCTION

Review question / Objective The main aim of this review was to critically identify whether the provision of shade (I) when compared to no shade provision (C), would improve the welfare (O) of grazing dairy cattle in temperate climates (P).

Rationale Mounting evidence indicates that heat stress is detrimental for the welfare of grazing dairy cattle and that different management strategies, such as the provision of natural and artificial shade, sprinklers and showers help mitigate these negative effects; however, literature reviews on this topic have focused on heat stress mitigation in tropical, hot and humid climates. Moreover, dairy production systems in temperate climates, often overlook heat stress as a critical welfare concern; hence, shade is rarely provided to grazing cattle.

Condition being studied Animals allocate their available time across different activities to meet their nutrition, thermal, comfort and social needs. The behavioural trade-offs involved, driven for example, by environmental constraints and resource availability, can ultimately compromise their welfare. For example, resting while lying down is a highly motivated natural behaviour, that is fundamental for cow comfort and welfare. However, when temperature, humidity and solar radiation are high, cows often prioritize standing to maximize surface area for cooling, thus negatively affecting resting and comfort. Furthermore, resting is often also impaired when food availability is low, as cows may compensate by extending foraging times even when environmental conditions fall outside of their comfort zone. While most efforts to address environmental impacts on cattle welfare have focused on severe climatic conditions, interest in evaluating these effects in more moderated climates has increased over the last 20 years. Therefore, identifying key strategies that

mitigate the effects of environmental factors on physiological responses and behavioural trade-offs of grazing dairy cattle can help us develop straight forward recommendations to improve animal welfare in temperate climates.

METHODS

Search strategy We searched for empirical studies evaluation the effects of shade provision on the welfare of grazing cattle in temperate climates in two databases (MEDLINE and Web of Science). We use Boolean operators as follow: (Cow OR Cows OR Cattle OR Dairy) AND (Shade) AND ("animal welfare" OR welfare OR "animal well-being" OR well-being OR "comfort" OR behaviour OR behavior OR motivation OR preference) AND (pasture OR grazing OR outdoor). The search was performed on March 02 2026.

Participant or population Primiparous or multiparous lactating dairy cows maintained under grazing, at least during part of the day, in temperate or mesothermal climatic conditions, with moderate temperatures and middle latitudes.

Intervention Provision of natural or artificial shade.

Comparator Absence of natural or artificial shade.

Study designs to be included No limits on study design imposed.

Eligibility criteria Articles included in this review should be peer reviewed, available in English or Spanish, described in vivo research, use primiparous or multiparous lactating dairy cows, use natural or artificial shade within a grazing area or paddock as an intervention, conducted within temperate or mesothermal climatic zones, include any of the following outcome measures: milk production, body condition, health, heart rate, body temperature, stress hormones, food consumption, foraging time, resting time, resting position, social behaviours, and shade use (preference and motivation). We will exclude systematic and narrative reviews, book chapters, conference abstracts, thesis, or editorials and articles published before the year 2000, studies carried out on other bovine species (e.g., bison, African buffalo, water buffalos, etc.), beef cattle, calves, bulls, pre-weaning heifers, heifers, feedlot cattle, cattle in barns, zero-grazing cattle, tropical, dry continental and polar climatic regions, non-grazing outdoor pens or corrals, studies with no detail description of the type of shade provided and that lack non-shade control or comparator.

Information sources MEDLINE and Web of Science.

Main outcome(s) Milk production, body condition, health, heart rate, body temperature, stress hormones, foraging time, resting time, resting position, social behaviours, and shade use (preference and motivation).

Data management We will use Covidence ((Covidence systematic review software, 2026) record management and screening, data extraction and quality assessment.

Quality assessment / Risk of bias analysis Each study will be assessed by two independent individuals and bias will be classified as low if criteria was met, high if criteria was not met and unknown if the information given did not allowed us to make a judgement for risk of bias:

1. Sequence generation (selection bias) – Were treatments allocated randomly using a sequence generation method?
2. Blinding of personnel (performance bias) – Were the investigators or personnel performing the experiments blind to treatment?
3. Blinding of outcome assessors (detection bias) – Were the observers scoring the behaviour blind to treatment and individual identification?
4. Incomplete outcome data (attrition bias) – Is the data for each outcome complete?
5. Selective outcome reporting (reporting bias) – Is there alignment and consistency in the outcomes reported between the study predictions, methods, and results?
6. Other bias – Were there any other important issues regarding bias?

Strategy of data synthesis For each study included in the review we will extract:

- 1) article identification: authors information, title, year and journal,
- 2) study design characteristics: sample size for control and treatment groups),
- 3) animal characteristics: breed, parity, age, coat color, lactation days
- 4) characteristics of the intervention and control conditions: type of shade, shade dimensions, level of radiation protection, location, duration of availability, detailed description of structures, and
- 5) the mean and variation (i.e., standard deviation or standard error) for each outcome measure.

Subgroup analysis NA.

Sensitivity analysis NA.

Language restriction We will impose no on language on the search beyond that of the databases themselves, although only studies in English and Spanish will be included in the review.

Country(ies) involved Mexico and Canada.

Keywords Cattle, Dairy Cow, Heat stress, Thermal comfort, Animal Welfare, Production, Temperate Climate, Shade, Shelter.

Contributions of each author

Author 1 - Lucia Améndola - Conceptualization and design. Research question, search strategy and protocol definition. Data base search. Title, abstracts, and full text screening. Data extraction and quality assessment. Analysis and interpretation. Writing, review and editing of the original manuscript.

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Author 2 - Marisol Ortiz-Texon - Conceptualization and design. Title, abstracts, and full text screening. Data extraction and quality assessment. Analysis and interpretation. Writing, review and editing of original manuscript.

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Author 3 - Ricardo Daniel Améndola-Massiotti - Conceptualization and design. Research question, search strategy and protocol definition. Title, abstracts, and full text screening. Data extraction and quality assessment. Analysis and interpretation. Writing, review and editing of the manuscript. Supervision, funding acquisition and project management.

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