












## Facilities for dairy cattle: an integrative review

### Instalações para bovinocultura leiteira: uma revisão integrativa

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**Abstract:** Evaluate the current scenario for dairy cattle housing. This is an integrative review study oriented by the following guiding question: "What is the scenario of the facilities used in the production of dairy cattle?" The bibliographical research was carried out using the ALICE, BDPA, SciELO, PubMed and SCOPUS databases, with the survey of references being carried out in December 2022 and January 2023, reaching the following quantitative bases: in ALICE of 01 article, in PubMed of 18 articles, SCOPUS 05 articles, totaling a quantity of 24 articles, after application of predetermined inclusion and exclusion criteria. At the end of reading each article, it was possible to organize them into the following categories: Dairy cattle facilities with a focus on housing, bedding, and general handling, and dairy cattle facilities with a focus on ambience and animal welfare; this categorization took place after being observed that 50% of the articles dealt with housing, bedding and handling and 50% dealt with the ambience and animal welfare. All articles selected for the sample corroborate the need for improvements in facilities for dairy cattle to avoid possible damage to animal welfare and unsatisfactory ambience, so that more rigorous systems such as the Tie Stall can be rendered unusable and make room for unconstrained systems such as Free Stall.

**Keywords:** ambience; animal welfare; dairy cattle; rural facilities; rural buildings.

**Resumo:** Avaliar o cenário atual para a criação de gado leiteiro. Trata-se de um estudo de revisão integrativa orientado pela seguinte questão norteadora: "Qual o cenário das instalações utilizadas na produção de gado leiteiro?" A pesquisa bibliográfica foi realizada nas bases de dados ALICE, BDPA, SciELO, PubMed e SCOPUS, sendo o levantamento de referências realizado em dezembro de 2022 e janeiro de 2023, atingindo as seguintes bases quantitativas: em ALICE de 01 artigo, em PubMed de 18 artigos, SCOPUS 05 artigos, totalizando um quantitativo de 24 artigos, após aplicação de critérios de inclusão e exclusão pré-determinados. Ao final da leitura de cada artigo foi possível organizá-los nas seguintes categorias: Instalações de pecuária leiteira com foco em alojamento, cama e manejo geral e instalações de pecuária leiteira com foco em ambiência e bem-estar animal; essa categorização ocorreu após ser observado que 50% dos artigos tratavam de alojamento, cama e manejo e 50% tratavam de ambiência e bem-estar animal. Todos os artigos selecionados para a amostra corroboram a necessidade de melhorias nas instalações para bovinos leiteiros para evitar possíveis danos ao bem-estar animal e ambiência insatisfatória, para que sistemas mais rigorosos como o Tie Stall possam ser inutilizados e abrir espaço para sistemas irrestritos como o Free Stall.

**Palavras-chave:** ambiente; bem-estar animal; edifícios rurais; gado leiteiro; instalações rurais.

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## 1. Introduction

Animal welfare is defined as the state of harmony between the animal and the environment in which it lives, and which can be improved as a result of the intervention that can be provided to it, such as food or accommodation<sup>(1)</sup>. This concept has been the subject of many discussions and so are the demands for actions that improve life quality of the animals, as a concern of the consumer market. Given this premise and seeking to satisfy these needs, producers seek to invest in better facilities, equipment and professional training, which in terms of the accommodation welfare, are extremely important for animals<sup>(2)</sup>.

The subject of welfare encompasses numerous stages of animal production, highlighting the influence of the environment, facilities, food and management. The facilities must be appropriate so that no damage occurs to the animals, promoting safety and good conditions<sup>(3)</sup>. Heat stress in dairy cattle directly interferes with their activities, inducing metabolic changes such as energy loss, increased respiratory rate, heart rate, rectal and surface temperature (PF), impairing the production of milk and reproduction<sup>(4)</sup>.

Given this scenario, it is important to adapt the structure of the facilities so that they can offer good management conditions, enabling the welfare of the animals, a factor extremely linked to the quality of milk, which makes this theme important both for producers and consumers<sup>(5)</sup>. Flores *et al*<sup>(6)</sup> analyzed possible problems in the facilities, equipment, handling and practices of pre-slaughter and slaughter of cattle, verifying that they directly affect the welfare in their pre-slaughter management of cattle.

In addition to adoption of more modern technologies to improve the internal environment of facilities, it is perceived the need for new techniques that bring sustainability, such as accommodations in which animals can express their natural behavior, which provide thermal comfort, causing greater safety and health that will improve their productivity<sup>(7)</sup>.

Aiming at improving breeding systems, new technologies were developed seeking to mitigate the negative effects of the environment on the animal and its production, for example the free stall and compost barn amongst them, which meet the market requirements in regards to animal comfort<sup>(8)</sup>, and the use of technologies in systems of breeding interferes in the behavior of the animals increasing their productivity<sup>(9)</sup>.

The compost barn system aims to integrate animal welfare and sustainability, which shows growth and increased expansion in several regions of Brazil, being a system of alternative breeding for dairy cattle, where the animals can express their instincts, increasing welfare indicators<sup>(10)</sup>. The accommodations of the compost system, originally named "Compost Bedded Pack Barn (CBPB)" features a shed with collective rest area with beds made of comfortable material for movement and accommodation of the animals, and, the particularity of this system is that the aerobic composting process of the beds<sup>(11)</sup>. Piovesan and Oliveira<sup>(12)</sup> evaluated factors such as pH, microbiological growth, humidity and fermentation in the composting barn beds, which influence the thermal comfort of cattle.

In Brazil, it is necessary to expand the information about installations of the Compost barn system, since its use can present high potential as an alternative to improve the

environment in the raising of dairy cattle and, consequently, an increase in production, therefore, getting to know this system model is important to obtain positive results in milk production, since it is a confinement model that has been expanding its presence and gaining preference from producers.

Accommodations are indispensable structures in any cattle breeding system, as it is where the animals will spend most of the day and, in addition, it is important to have a good sizing to avoid accidents during animal handling and ensure a good general situation during production, thus avoiding stress<sup>(13)</sup>. The facilities must be wide and airy, seeking the most possible comfort and, as a set of factors related to well-being in these accommodations, such as cleaning feed bins, which must be done daily, especially on rainy days<sup>(2)</sup>.

The free stall system appeared in the 50's in the United States, and in the 80's in Brazil, presenting advantages such as ease of mechanization and flexibility in handling, consisting of a covered shed that features free and individual pens<sup>(14)</sup>. Gonçalves *et al.*<sup>(15)</sup> analyzed a free stall system quoting that, during the winter the temperatures remain within thermal neutrality for the animals, while in summer temperatures increase, causing stress and impairing animal performance.

Animal welfare is directly influenced by the structure of the installations systems, which must be equipped with innovative construction techniques and materials in a way that the ambience and animal welfare are satisfactory. Future housing systems should also include new designs and layouts that play an increasingly important role in the improvement of animal comfort and in the expression of their natural behavior, resulting in higher productivity. Therefore, the present study aimed to evaluate the current scenario for accommodation of dairy cattle.

## 2. Materials and methods

This article is an integrative review (IR) study, as a compendium of several investigations in order to produce systematic knowledge about a problem in evidence, thus gathering summaries of studies already carried out on numerous methodological approaches, enabling a rigorous analysis and bringing together the epistemology of empirical research, integrated through eligibility.

The IR was carried out in various phases, such as: formulating a guiding question; search or sampling in the literature; data collection; critical analysis of the selected studies that were included; thematic categorization; discussion of the presented results and the presentation of the frame review. This process was elaborated with the aid of an integrative review protocol.

The guiding question of the research was: "What is the scenario of the facilities used in the dairy cattle production?"

The bibliographical research was carried out through the ALICE databases (Embrapa Free Scientific Information Access), BDPA (Agricultural Research Database EMBRAPA), PubMed (National Library of Medicine National Institutes of Health), SciELO (Scientific Electronic Library Online) and Scopus (SciVerse Scopus).

To perform the searches in the databases, the following keywords were used: “Dairy cattle”, “Ambience”, “Animal welfare”, “Rural facilities”, “Rural constructions”, and the corresponding keywords in English “Dairy cattle”, “Environment”, “Welfare”, “Rural facilities”, “Rural buildings”. Consequently, the following search expressions were formed: 1. (“Dairy cattle”) AND (“Ambience”) AND (“Rural facilities”) AND (“Rural buildings”) AND (“Animal welfare”); 2. (“Bovine dairy”) AND (“Rural facilities”) AND (“Rural buildings”); 3. (“Dairy cattle”) AND (“Ambience”) AND (“Animal Welfare”); 4. (“Dairy cattle”) AND (“Rural facilities”) AND (“Ambience”), the same expressions were formed with the aforementioned Keywords.

The inclusion criteria used in the selected research articles were published in the last five years (2018, 2019, 2020, 2021, 2022, 2023) in Portuguese, English and Spanish, available in full text for free. Studies that were not in the form of scientific papers were excluded, as well as the articles that did not fit the purpose of the study.

The compilation of references was carried out in December 2022 and January 2023, reaching a number of: 1 article in ALICE database, in the BDPA 0 articles, in PubMed 18 articles, at SciELO 0, and in Scopus 5 articles, totalizing 24 articles. Below, is a detailed flowchart of the phases of the searches according to inclusion and exclusion criteria (Figure 1).

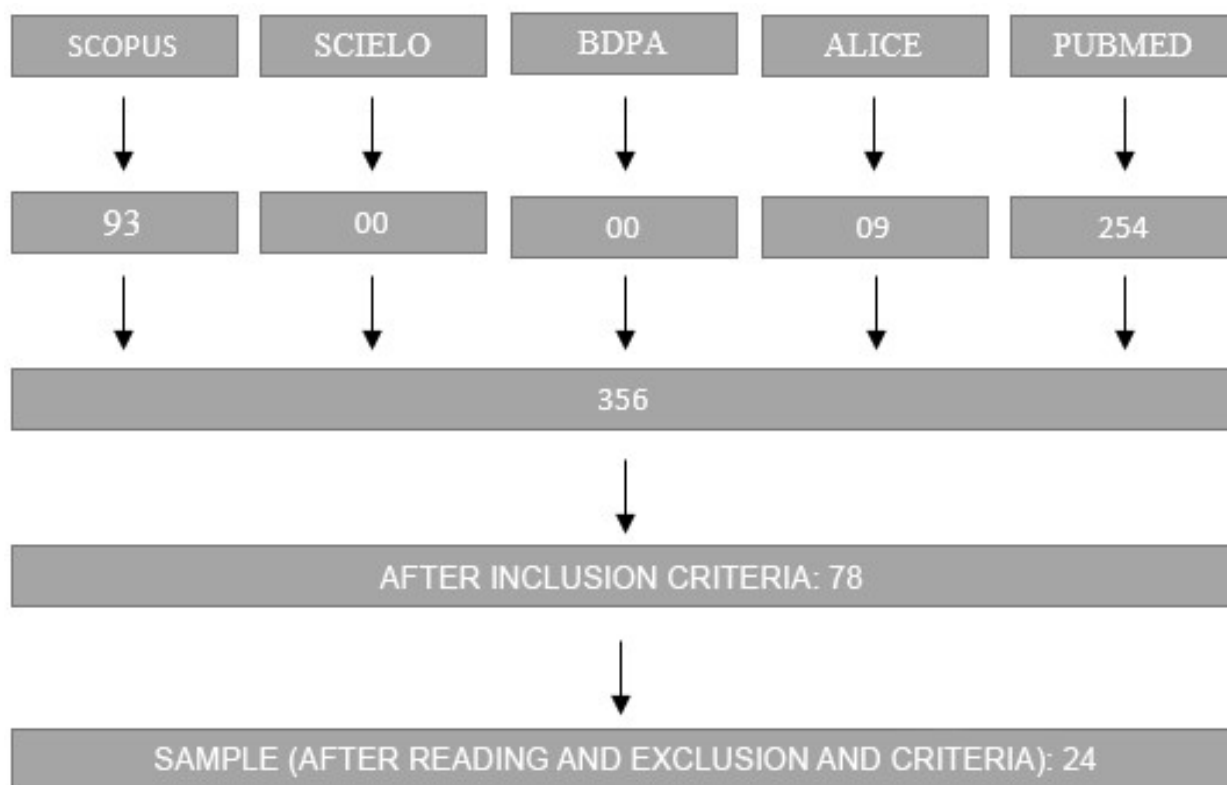


Figure 1 Flowchart showing the selection of the included articles. Campina Grande – PB, 2023. Source: Survey data, 2023.

For better sampling analysis, thematic categorization was carried out according to the affinity of the included studies. At the end of reading each article, it was possible to organize them in the following categories: Dairy cattle facilities with a focus on housing, bedding and handling and dairy cattle facilities with a focus on ambience and animal welfare. The

categorization took place after observing that 50% of the articles dealt with accommodation, beds and handling and 50% dealt with the ambience and animal welfare in the essence of their objective.

Categorization is important for understanding and disseminating knowledge. Additionally, Mendeley software was used to manage references.

Furthermore, analyzing the design of the studies, the classification by level of evidence (I, II, III, IV or V):

- I. Systematic reviews (or meta-analysis) of randomized trials;
- II. Randomized controlled trials;
- III. Studies without randomization, cohort, or case-control studies;
- IV. Non-experimental studies;
- V. Opinions of authorities based on scientific evidence<sup>(16)</sup>.

### 3. Results

Four tables were prepared, summarizing the information of the selected articles for the study sample, emphasizing that they were renamed in order to facilitate comprehension, so the tables were titled as A1, A2, A3, (...), A23, A24.

In Table 1, the references of the selected articles are shown, as well as the databases where they were found based on inclusion and exclusion criteria. The following information is highlighted: databases, authors, title, journal and year of publication.

**Table 1** References included in the integrative review, according to the consulted databases, authors, title, journal and year of publication. Campina Grande – PB, 2023.

N°	Database	Authors/Year	Title	Journal
A1	PUBMED	Salfer et al. <sup>(17)</sup>	Housing, management characteristics, and factors associated with lameness, hock lesion, and hygiene of lactating dairy cattle on Upper Midwest United States dairy farms using automatic milking systems	Journal of Dairy Science
A2	PUBMED	Roches et al. <sup>(18)</sup>	Do International Commission of Agricultural and Biosystems Engineering (CIGR) dimension recommendations for loose housing of cows improve animal welfare?	Journal of Dairy Science
A3	PUBMED	Carter et al. <sup>(19)</sup>	Dairy cows value an open area for lying down	PLOS ONE
A4	PUBMED	Alsaad et al. <sup>(20)</sup>	Locomotion behavior of dairy cows on traditional summer mountain farms in comparison with modern cubicle housing without access to pasture	PLOS ONE
A5	PUBMED	Schütz et al. <sup>(21)</sup>	Stepping behavior and muscle activity of dairy cattle standing on concrete or rubber flooring for 1 or 3 hours	Journal of Dairy Science
A6	PUBMED	Jackon et al. <sup>(22)</sup>	Understanding public preferences for different dairy farming systems using a mixed-methods approach	Journal of Dairy Science
A7	PUBMED	Lowe et al. <sup>(23)</sup>	The effect of diet and covering fully slatted concrete floors with rubber strips on the intake, performance and cleanliness of dairy bulls	The International Journal of Animal Biosciences
A8	PUBMED	Lowe et al. <sup>(24)</sup>	Effect of overlaying rubber on fully slatted concrete floors on hoof health and lying postures in finishing dairy-origin bulls offered two contrasting diets	The International Journal of Animal Biosciences

<b>A9</b>	PUBMED	Gieseke et al. <sup>(25)</sup>	Effects of cubicle characteristics on animal welfare indicators in dairy cattle	The International Journal of Animal Biosciences
<b>A10</b>	PUBMED	Schütz et al. <sup>(26)</sup>	Effects of 3 surface types on dairy cattle behavior, preference, and hygiene	Journal of Dairy Science
<b>A11</b>	PUBMED	Horvath et al. <sup>(27)</sup>	Effects of access to stationary brushes and chopped hay on behavior and performance of individually housed dairy calves	Journal of Dairy Science
<b>A12</b>	PUBMED	Bučková et al. <sup>(28)</sup>	Pair housing makes calves more optimistic	Scientific Reports
<b>A13</b>	PUBMED	Beaver et al. <sup>(29)</sup>	Invited review: The welfare of dairy cattle housed in tie stalls compared to less-restrictive housing types: A systematic review	Journal of Dairy Science
<b>A14</b>	PUBMED	Shepley et al. <sup>(30)</sup>	Graduate Student Literature Review: The effect of housing systems on movement opportunity of dairy cows and the implications on cow health and comfort	Journal of Dairy Science
<b>A15</b>	PUBMED	Ritter et al. <sup>(31)</sup>	Views of American animal and dairy science students on the future of dairy farms and public expectations for dairy cattle care: A focus group study	Journal of Dairy Science
<b>A16</b>	PUBMED	Carter et al. <sup>(32)</sup>	Dairy cow trade-off preference for 2 different lying qualities: Lying surface and lying space	Journal of Dairy Science
<b>A17</b>	PUBMED	Gieseke et al. <sup>(33)</sup>	Relationship between herd size and measures of animal welfare on dairy cattle farms with free stall housing in Germany	Journal of Dairy Science
<b>A18</b>	PUBMED	Jensen et al. <sup>(34)</sup>	A survey on management and housing of peri-parturient dairy cows and their calves	The International Journal of Animal Biosciences
<b>A19</b>	SCOPUS	Crossley et al. <sup>(35)</sup>	Risk factors associated with indicators of dairy cow welfare during the housing period in Irish, spring-calving, hybrid pasture-based systems	Preventive Veterinary Medicine
<b>A20</b>	SCOPUS	Shepley et al. <sup>(36)</sup>	Housing tie stall dairy cows in deep-bedded pens during an 8-week dry period: Effects on lying time, lying postures, and rising and lying-down behaviors	Journal of Dairy Science
<b>A21</b>	SCOPUS	Lardy et al. <sup>(37)</sup>	Refinement of international recommendations for cubicles, based on the identification of associations between cubicle characteristics and dairy cow welfare measures	Journal of Dairy Science
<b>A22</b>	SCOPUS	Thompson et al. <sup>(38)</sup>	Field survey to evaluate space allowances for dairy cows in Great Britain	Journal of Dairy Science
<b>A23</b>	SCOPUS	Thompson et al. <sup>(39)</sup>	A randomised controlled trial to evaluate the impact of indoor living space on Dairy cow production, reproduction and behaviour	Scientific Reports
<b>A24</b>	ALICE	Kamchen et al. <sup>(40)</sup>	Influence of different materials for covering mobile shelters in the thermal comfort of calves in the climatic conditions of Sinop / MT	Scientific Electronic Archives

Source: Survey data, 2023.

Analysis of the first table shows that 75% of the articles were found in the PubMed database, 20.83% on Scopus and 4.17% on ALICE. In regards to periodicals, 58.43% of the articles are from the Journal of Dairy Science, 16.67% from The International Journal of Animal Biosciences, 8.33% from PLOS ONE, 8.33% from Scientific Reports, 4.17% from Preventive Veterinary Medicine and 4.17% Scientific Electronic Archives. As for the year, 29.17% were from 2019, 20.83% were from 2022, 16.67% were from 2018, 2020 and 2021.

In Table 2, relevant information regarding the characteristics of the studies were included, such as: type of study, country of origin, study delimitation and level of evidence from selected scientific articles.

**Table 2 Type of study, country of origin, epidemiological delimitation, level of evidence of selected scientific articles. Campina Grande – PB, 2023.**

<b>Type of study</b>	Quantitative: A1, A2, A3, A4, A5, A7, A8, A9, A10, A11, A12, A13, A16, A17, A18, A19, A20, A21, A22, A23, A24 Quanti-qualitative: A6 Qualitative: A14, A15
<b>Country of origin</b>	United States: A1, A5, A11 France: A2, A21 United Kingdom: A3, A6, A22, A23 Switzerland: A4 Ireland: A7, A8, A19 Germany: A9, A17 New Zealand: A10 Czech Republic: A12 Canada: A13, A14, A15, A20 Scotland: A16 Denmark: A18 Brazil: A24
<b>Study delimitation</b>	Observational: A1, A2, A6, A9, A15, A17, A18, A19, A21, A22 Experimental: A3, A4, A5, A7, A8, A10, A11, A12, A16, A20, A23, A24 Systematic Review: A13 Review: A14
<b>Level of evidence (I, II, III, IV, V)</b>	I: A13 II: A3, A4, A5, A7, A8, A10, A11, A12, A16, A20, A23, A24 III: IV: A1, A2, A6, A9, A14, A15, A17, A18, A19, A21, A22 V:

Source: Survey data, 2023.

When verifying Table 2, it is observed that 87.5% of the studies had a quantitative methodical approach, 8.33% qualitative and 4.17% quantitative-qualitative. As for the country of origin, most searches were conducted in Canada (16.67%) and the United Kingdom (16.67%), some in the United States of America (12.5%) and Ireland (12.5%), a few in France (8.33%) and Germany (8.33%) and the minority were executed in Brazil (4.17%), Denmark (4.17%), Scotland (4.17%), New Zealand (4.17%), Switzerland (4.17%) and Czech Republic (4.17%).

Regarding the delimitation of the studies, 50% were experimental, 41.67% were observational, 4.17% systematic review and 4.17% review. Finally, the level of predominant scientific evidence was level II (50% of the articles), which demonstrates the quality of the sample of selected studies.

Table 3 shows the result of reading and meticulous analysis of the articles that enabled the understanding and absorption of information, which were classified into two categories according to their similarities and evidence, they are: Dairy cattle facilities focusing on housing, bedding and management and facilities for dairy cattle focusing in ambience and animal welfare.

**Table 3 Categorization of selected scientific articles. Campina Grande – PB, 2023**

Dairy cattle facilities focusing on housing, bedding and management	A1, A2, A3, A5, A6, A7, A10, A14, A18, A20, A21, A22
Facilities for dairy cattle focusing in ambience and animal welfare	A4, A8, A9, A11, A12, A13, A15, A16, A17, A19, A23, A24

Source: Survey data, 2023.

Analyzing table 4, the importance of the quality of the material used in the bedding or on the resting surfaces of the cows is perceived, as well as systems that allow a greater movement and rest in open, clean and dry areas. Furthermore, the management and accommodation should aim at animal welfare and ambience quality as a priority and essence in its facilities, which will improve its productivity, enabling a greater profit to producers. On the other hand, some systems of the current scenario mentioned above, such as the tie stall system, can be detrimental to animal welfare.

**Table 4 General objective and main results of the studies included in the sample, Campina Grande – PB, 2023**

N°	Study Objectives	Study Results
A1	To describe the practices of housing and management on farms that use automatic milking systems.	Of the responses from 37 of the farms in the study, 38% reported having ≤1% of cows that failed to adapt to the system, 49% had >1% and ≤5% that adapted, 3% had >5 and <10% that failed to adapt, and 11% had ≥10% who failed to adapt as well. Another four farms continued to milk cows that did not adapt to automatic milking systems in a conventional milking parlour.
A2	To describe the extent to which dairy farms have met the International Commission On Agricultural Engineering recommendations for pen dimensions and automatic barriers.	The recommendations for the stalls were met mainly for the resting length (75.9%) and for the distance from the rail to the neck (60.7%), while the recommendations for automatic barriers were met mainly for the height of the lower rail (68.2%), separation wall width (68.3%) and top rail height (56.9%).
A3	To assess cows' motivation to lie on beds in open resting areas when they also have free access to stalls with resting beds.	Cows lay longer in the open resting areas compared to the resting stalls. In addition, they had a high motivation for an open resting area, a provision which could better meet behavioral needs and improve well-being.
A4	To assess the locomotion activity of healthy dairy cows kept on traditional mountain pastures using validated accelerometers.	Cows kept on pasture spent less time lying down and more time walking, while cows kept in stalls spent more time lying down.
A5	To investigate the potential benefits of providing a floor surface of rubber for dairy cattle.	The results show that standing on a rubber floor caused a different initial behavioral response compared to standing on a concrete floor. However, possible reasons for these changes are unclear. Standing for 3 h resulted in an increase in step rate and in some muscle activity parameters; However, the results referring to muscle fatigue in relation to the type of floor are inconclusive.
A6	To understand the perspective of the participants regarding three milk production scenarios incorporating different amounts of pasture or housing.	The integrated results indicated that the participants had a double view of the cow, seeing it as domestic and wild, idealizing a scenario with facilities for the winter and pasture in the summer. The interviewees also confessed to being unaware of the needs of the cow.
A7	To evaluate the effect of diet and type of flooring on intake, performance and cleanliness of dairy bulls from an average age of 8 months to slaughter, at 15.5 months of age.	The floor type had no significant effect on intake. The offered diet had no significant effect on the performance of the animals. Bulls housed on rubber-covered slats were significantly cleaner than those housed on concrete slats.
A8	To evaluate the effect of the floor and the diet on the health of hooves and bedtime behavior of housed dairy bulls from an average age of 8 months to slaughter, at 15.5 months of age.	The number of bruises was significantly higher in bulls housed on concrete slatted floors than on rubber-coated concrete slats.
A9	To estimate the effects of bedding characteristics on animal welfare indicators in dairy cattle.	Bedding type was found to be the most influential factor in terms of health and behavior. Wider beds positively affected the proportion of dairy cows with dirty flanks, but increased the number of cows with severe tegument changes. Larger resting areas reduced the percentage of cows with dirty udders.



<b>A10</b>	To evaluate the use and preference for three different types of wood chip (clean, wet, or dirty with feces).	Rebound responses indicate that the motivation to rest is not fulfilled on wet surfaces, when given a choice, they clearly show that they will avoid wet and dirty surfaces.
<b>A11</b>	To examine the effects of increasing behavioral opportunities for dairy calves on performance and behavioral outcomes by providing forage in addition to starter and brushes.	Feeding hay tended to increase solid feed intake and average daily gain during weaning, and calves given a brush had improved coat cleanliness during weaning.
<b>A12</b>	To evaluate the performance and affective state of individually and pair housed calves.	Installation did not affect learning speed, but calves housed in pairs responded more positively to ambiguous cues than calves housed singly.
<b>A13</b>	To summarize the scientific literature regarding the welfare of dairy cattle housed in pens by comparing them with less restrictive housing systems.	Expression of certain natural behaviors, particularly those associated with lying down (such as: time spent kneeling, unfulfilled intentions to lie down), were impaired in tie stall system.
<b>A14</b>	To provide a literature review to determine how the level of opportunity for movement provided through different handling and housing practices affects the health of hooves, legs and limbs.	Opportunity for movement, briefly summarized as the level of locomotor activity a cow is able to express in its given environment, as well as the ease with which that movement can be expressed, can have a direct and substantial effect on cow comfort.
<b>A15</b>	To evaluate undergraduates' view about the future of dairy farming.	Students often failed to distinguish between mandatory topics that promote animal health and welfare and changing animal care practices with the public expectation.
<b>A16</b>	To investigate the importance the cows attached to the type of surface and open spaces other than a resting area.	On average, when a free stall was reset to the cow's preferred surface, which were faced with a tradeoff between lying on their preferred surface or an open space on a less preferred surface, most of these cows chose the open space.
<b>A17</b>	To examine the relation of herd size with animal welfare in dairy cattle herds.	Housing conditions and management practices seemed to have a greater effect on animal welfare than the number of dairy cows per farm.
<b>A18</b>	To provide an overview of current birthing practices and describe the main housing and delivery management based on online questionnaire responses.	The most frequently reported bedding surface was straw and the most frequent type of separation between pens was open sides. Separating the calf within 12 hours of birth and then individually housing the calves combined with milk feeding via a bucket or bottle was indicated as the most frequent management.
<b>A19</b>	To identify risk and protective factors for a variety of welfare indicators during the confinement period on dairy farms hybrids based on pasture with calving in spring.	Thirty-six unique risk factors were associated with one or more welfare indicators, the risk factor associated with multiple welfare indicators were cow comfort index, slippery floor, light level, width spillway and the presence or absence of a gate supporting the collecting/gathering yard.
<b>A20</b>	To determine if the housing tie stall dairy cows in a deep-bed loose pen during an 8-week dry period increased the amount of time that the cows passed laying down and/or improved the ease of movement.	Untied cows are able to assume more posture than tie stall cows when there is more room, possibly allowing them to orient themselves in a more comfortable way. The lying surface in the loose pen may facilitate the cow's lying and rising movements and lead to the longer lying time found in loose pen cows.
<b>A21</b>	To Model the association between combinations of pen dimensions in relation to cow size and other bedding properties as well as the prevalence of dairy cow skin changes, lameness, and soiling.	That obstacles in the lateral plane must be positioned in such a way as to avoid contact.
<b>A22</b>	To explore the current housing of dairy cows across Great Britain, with a specific focus on understanding the practice and variability associated with area concession.	The study revealed that farmers felt that grazing space was essential for cows' well-being, with more than half of farmers scoring $\geq 8$ on a scale of 0 to 10.
<b>A23</b>	To investigate the impact of increased living space on critical aspects.	Cows with increased space produced more milk through 305 days of lactation, but took longer to become pregnant after calving. In terms of behavior, cows with more living space spent significantly more time in lying areas and significantly less time on pasture, suggesting greater well-being when more space was provided. A key physiological difference between the groups was that cows with more space spent more time ruminating each day.
<b>A24</b>	To evaluate the variables: temperature, relative air humidity, temperature-humidity index (THI), in addition to the cost-benefit of recyclables of materials used in covering mobile shelters.	There was no statistical difference between the coverage of the mobile shelters and in relation to the control for the daily averages of temperature, relative humidity and temperature-humidity index.

Source: Survey data, 2023.

## 4. Discussion

After a thorough reading of articles A1, A2, A3, A5, A6, A7, A10, A14, A18, A20,

A21 and A22; it was possible to group them in this category due to their similarity of objective and results focusing on housing, bedding and management of dairy cattle facilities.

They all point to relevant results corroborating new technologies, types of bedding and more suitable flooring and more frequent handling<sup>(17-19,21-23,26,30,34,36,38)</sup>.

Studies A1 and A2 show results related to the implementation of new technologies in the facilities. The A1 shows that the majority of a herd of cows can adapt to automatic milking systems, while the A2 points out recommendations from the International Association of Agricultural Engineering Commission, which were addressed in this article mainly for resting length and for automatic barriers mainly for height<sup>(17,18)</sup>.

Articles A3, A10, A18 and A20 mostly address the importance of bedding and resting surface for cows. A3 confirms that cows lie down for longer in open resting areas than in resting stalls, the A10 proves that cows avoid wet and dirty surfaces and have a preference for dry surfaces, the A18 brought straw as the predominant bedding surface, while the A20 shows that loose cows can assume more lying postures than cows in Tie Stall<sup>(19,26,34,36)</sup>.

Articles A5 and A7 reveal results about the floor used in accommodation. In A7, dairy bulls housed in rubber-covered slats were significantly cleaner than those accommodated in concrete slats, corroborating A5, which states that standing on a rubber floor stimulates a different initial behavioral response compared to the concrete floor<sup>(21,24)</sup>.

Studies A6, A14 and A22 show the importance of pasture and cow movement activity. In A6, participants interviewed in the UK envision a scenery with facilities for the winter period and pasture for the summer period, reaching consensus with A14 which found as a result that the level of locomotor activity can have a direct and substantial effect on the comfort of the cows, in addition, in A22, ranchers consider pasture space essential<sup>(22,30,38)</sup>.

Finally, A18 and A21 discuss the handling and use of obstacles between the stalls. In A18, the division between the pens was often open on the sides and the calves were individually housed, with the most frequent feeding management being the supply of milk per half of buckets or baby bottles. On the other hand, A21 points out that the side obstacles must be positioned to avoid contact and decrease the prevalence of skin changes<sup>(34,37)</sup>.

In studies A4, A8, A9, A11, A12, A13, A15, A16, A17, A19, A23, A24 was verified that all, without exception, addressed animal welfare and ambience in its essence and in their general objectives, although they dealt with several aspects<sup>(20,24,25,27,28,29,31,33,35,39,40)</sup>.

Articles A4 and A13 proved the importance of locomotion for animal welfare. A4 performed an experiment demonstrating that cows kept on pastures spent less time lying down and more time walking, while cows kept in stalls spent more time lying down. A13, on the other hand, stated that the expression of certain natural behaviors, particularly those associated with lying down (e.g., long spending kneeling, unfulfilled intentions to lie down, among others), was impaired in the tie tall system as they do not have the possibility of

locomotion, since the cows are tied<sup>(20,29)</sup>. Studies A8, A9 and A15 generally verified the type of surface, bed and floor with focus on influencing animal welfare. The A8 showed that the presence of bruises was significantly higher in bulls housed on concrete slatted floors than in rubber coated concrete slats<sup>(24,25,31)</sup>.

While the A9 showed that the type of bed was found to be the most influential factor in terms of health and behavior, in addition, larger resting areas reduced the percentage of cows with dirty udders. A15 interviewed undergraduate students who have often failed to distinguish the obligatory themes that promote health and animal well-being and changes in animal care practices<sup>(33,31)</sup>.

Articles A11, A12, A17, A19 and A24 revealed the influence of management, feed, and facilities to animal welfare. A11 performed an experiment providing hay, which caused an increase in solid feed intake and an average daily gain during weaning, in addition, the calves that received a brush improved the cleaning of the coat during weaning. A12, on the other hand, performed an experiment testing the calf learning, but the type of facility did not affect the speed of learning, however, calves housed in pairs responded more positively to ambiguous cues than individually housed calves, which shows the importance of living in pairs<sup>(27,28,33,35,40)</sup>.

A17 found that housing conditions and management practices seem to have a greater effect on animal welfare than the number of dairy cows per farm, corroborating with article A19 that investigated thirty-six risk factors that were associated with one or more indicators of welfare. On the other hand, A24 identified that there was no statistical difference between the coverage of mobile shelters and in relation to the control for the average daily temperatures, relative humidity and temperature-humidity index (THI)<sup>(33,34,40)</sup>.

Finally, A16 and A23 added knowledge regarding space and its influence for animal welfare. A16 performed an experiment in which, on average, when a free stall was reset to the cow's preferred surface, and these animals were confronted with a switch between lying down on your preferred surface or an open space with a less preferred, most of these cows chose the open space, corroborating the A23<sup>(32,39)</sup>.

Lastly, A23 also applied an experiment in which cows with increased space produced more milk for 305 days of lactation. In terms of behavior, the cows with more living space spent significantly more time in areas lying down and significantly less time on pasture, suggesting a scenario of greater welfare when more space was provided. A key physiological difference between the groups was that the cows with more space spent more time ruminating each passing day<sup>(39)</sup>.

Therefore, according to these results, dairy cattle should ideally have open space for grazing, promoting better performance, mobility and animal well-being. As for resting, they also prefer to lie down on open surfaces, even when they are not their preferred surfaces. However, when open space is not available, the best type of bedding for stalls is one covered with rubber, as it prevents bruising and also makes the surface drier and cleaner. Regarding facilities for dairy cattle, the Free stall system is the most suitable when there is no possibility

of open space for pasture. In it, there are individual stalls, but there is also adequate space for movement within the system, promoting ideal parameters for animal welfare. On the other hand, there is the Tie stall system, which is not recommended because it keeps dairy cattle restricted to their stalls, making movement and mobility impossible, as well as causing more harm to animal welfare and more body bruises.

## 5. Conclusion

Most of the samples of scientific articles included in this review were found in the PubMed database, mainly in the Journal of Dairy Science and most were from 2019. Mostly, they were studies carried out in Canada with a quantitative approach and experimental design, classifying them, for the most part, at level of evidence II.

It is important to take into consideration that, when reading the studies, great similarity between them was observed, allowing them to be grouped into two different categories, 50% in the category "Facilities for dairy cattle with a focus on housing, bedding and management" and 50% in the category "Facilities for dairy cattle with a focus on in ambience and animal welfare".

Therefore, the analysis through categorization gave the perception that the current scenario of facilities for dairy cattle began to show more interest on the context of ambience and animal welfare, which consequently generates better results in productivity and more profit for the producer.

Unfortunately, however, some systems that are detrimental to animal welfare remain in use, such as the tie stall, which is not very suitable, and should be replaced by systems that value animal welfare aligned with good productivity. Therefore, new studies should be carried out in this line so that there is more evidence and basis that corroborate this same perspective.

### Conflict of interests

The authors declare no conflict of interest.

### Author contributions

Tacila Rodrigues Arruda, Conceptualization, Formal Analysis, Investigation, Visualization, Writing (original draft), Writing (review and editing). Jéssica Guimarães Barros, Conceptualization, Formal Analysis, Investigation, Visualization, Writing (original draft), Writing (review and editing). Luiza Lira Leite, Conceptualization, Formal Analysis, Investigation, Visualization, Writing (original draft), Writing (review and editing). Yanka Beatriz Gonçalves Batista, Conceptualization, Formal Analysis, Investigation, Visualization, Writing (original draft), Writing (review and editing). Dermeval de Araújo Furtado, Conceptualization, Formal Analysis, Investigation, Visualization, Writing (original draft), Writing (review and editing). Neila Lidiany Ribeiro, Conceptualization, Formal Analysis, Investigation, Visualization, Writing (original draft), Writing (review and editing). Brendo Júnior Pereira Farias, Conceptualization, Formal Analysis, Investigation, Visualization, Writing (original draft). Ivson de Sousa Barbosa, Conceptualization, Formal Analysis, Investigation, Visualization, Writing (original draft). José Ilton Pereira Alves Conceptualization, Formal Analysis, Investigation, Visualization, Writing (original draft)

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