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Influence of farm size on dairy housing welfare scores in Karnataka

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Abstract
This study was undertaken to compare the influence of farm size on dairy farm housing welfare scores in Karnataka, India. A total of 60 dairy farms of Karnataka were considered. The farms were grouped into small, medium and large as per the prevailing dairy cattle holding in the region. The mean scores of the welfare indicator 'Housing type and space availability', 'Type & height of roof' and 'Type of floor' in small, medium & large dairy farms out of total score of 10, 3 and 2, was 6.53 ± 0.414, 5.75 ± 0.479 & 4.75 ± 0.360; 1.53 ± 0.128, 1.60 ± 0.134 & 1.85 ± 0.109 and 0.53 ± 0.085, 0.68 ± 0.116 & 0.90 ± 0.112, respectively. The mean scores of the welfare indicator 'Microclimate protection measures', 'Feeding and watering space availability' and 'Milking system' in small, medium & large dairy farms, out of total score of 5, was 1.95 ± 0.246, 1.60 ± 0.285 & 1.65 ± 0.167; 3.70 ± 0.128, 3.95 ± 0.050 & 4.00 ± 0.073 and 2.10 ± 0.069, 2.35 ± 0.109 & 2.85 ± 0.082, respectively. The mean housing component welfare score of small, medium and large dairy farms, out of total score of 30, was 16.33 ± 0.671, 15.93 ± 0.719 and 16.00 ± 0.429, respectively; with no significant differences between groups. There were no significant differences in welfare scores of small, medium and large dairy farms of Karnataka, as the significant differences among the various sub-components of the welfare score cancelled each other out in the overall score.

Keywords: dairy cattle welfare, farm size, housing, Karnataka

Introduction
Animal husbandry serves as a crucial livelihood source for numerous farmers and has significantly contributed to the development of India's rural economy. Dairy farming, in particular, is seen as a viable and profitable enterprise, offering consistent supplementary income, productive employment opportunities, and improved nutritional support for families throughout the year. As per the DAHDF, 2019 [2]. India has the highest dairy cattle population in the world, including 193.46 million cattle, which accounts for 36.04 per cent of total farm animals in the country, and 109.85 million buffaloes. The livestock sector has contributed nearly 4.11% to India's Gross Domestic Product (GDP), which is about 21.58% of agricultural GDP. Karnataka ranks eleventh in overall milk production in India with annual milk production of about 11 million metric tonnes (BAHS, 2019). Animal welfare is an expansive concept that encompasses the well-being of all animal species. While early focus was primarily on the welfare of domesticated animals, it has gradually evolved into a global issue, attracting widespread concern. The term 'animal welfare' refers to an animal's ability to adapt and function—physiologically, behaviourally, cognitively, and emotionally—within its physical, chemical, and social environment, including the animal's own subjective experience of its condition (Scott *et al*., 2001) [9]. Rising consumer awareness about animal welfare has resulted in increased demand for livestock products from farms that uphold high welfare standards, potentially leading to higher prices and greater profits. However, the lack of data on dairy cattle welfare in Karnataka poses a significant obstacle to creating policies aimed at improving animal welfare. This study was carried out to evaluate the welfare status of dairy cattle across farms of various sizes.

Materials and Methods
Karnataka ranks sixth among the largest states in India by geographical area, located in the western region of the Deccan Plateau. It is one of the country's key agricultural states, characterized by a relatively high density of livestock, with animal husbandry being a significant component of the rural economy. Bengaluru Rural and Kolar districts were intentionally chosen to represent the peri-urban and rural areas of Karnataka, respectively. Both Bengaluru Rural (with a population of 3,24,583) and Kolar (with 2,09,642) are home to a large number of crossbred cattle and are prominent milk producers in the state.

The objective of this study was to evaluate the welfare status of dairy cattle across farms of varying sizes. A purposive random sampling method was employed to select livestock-owning households and assess cattle welfare. A total of 60 dairy farms in Karnataka were included in the study. These farms were categorized based on the number of adult cattle into small (1-2), medium (3-10), and large (>10)

groups, in line with regional herd size patterns. Welfare assessment was conducted using resource- and environment-based indicators by using the Dairy Cattle Welfare Scale (DCWS) developed by Kumar (2016) [6] with suitable modifications keeping in view the farming practices and local conditions of the study area. The basic components of the welfare scale were developed by Calamari and Bertoni (2009) [4] based on Integrated Diagnostic System Welfare (IDSW). This scale was modified by Kumar (2016) [6] according to Indian conditions to meet "Five Freedoms" of animal welfare and feasibility of their measurement under prevalent conditions.

Assessment of the dairy housing welfare status of the farms was done using six indicators with a total score of 30: Housing type and space availability (10), Type and height of roof (3), Type of floor (2), Microclimate protection measures (5), Feeding and watering space availability (5), and Milking system (5). Details of the sub-components under each indicator are given in Table 2.

Fig 1: Medium-sized dairy farm with rubber cow mats

Results and Discussion
The overall mean scores of the welfare indicator 'housing and other facilities' in dairy farms of different sizes are presented in Table 1, with detailed breakup in Table 2. The mean welfare score in small, medium and large dairy farms, out of total score of 30, was 16.33 ± 0.671, 15.93 ± 0.719 and 16.00 ± 0.429, respectively, with an overall score of 16.08 ± 0.352. The mean welfare score of this indicator had no significant difference between the groups.

Housing type & space availability: The mean welfare scores in small, medium and large dairy farms, out of total score of 10, were 6.53 ± 0.414, 5.75 ± 0.479 and 4.75 ± 0.360, respectively, with an overall welfare score of 5.68 ± 0.257. The mean welfare score of this indicator in small dairy farms was significantly ($P<0.05$) higher than large farms, primarily due to better housing type, covered area, open area and ventilation in small farms compared to other farms. Similar findings were reported by Mahla (2018) [7] (5.30 ± 0.71, 4.90 ± 0.70 and 4.10 ± 0.59). In contrast, higher scores were reported in large farms by Kumar (2016) [6] (7.00 ± 0.45) and Adhikari (2021) [1] (8.80 ± 0.80). The welfare score of small farms was significantly higher than large farms because most had loose housing system with more than recommended covered/open area and good ventilation. The low welfare score in large dairy farms was mainly due to tie-stalls with limited standing space and open space with below recommended standards. However, they had better lighting than the other groups.

Type and height of roof: The mean scores in small, medium and large dairy farms, out of total score of 3, were 1.53 ± 0.128, 1.60 ± 0.134 and 1.85 ± 0.109, respectively, with an overall welfare score of 1.66 ± 0.073, and no significant difference between the groups. Comparatively, large farms had higher score in the present study due to better roof material and ridge height. The observations were in agreement with the findings of Rajpoot (2019) [8] (1.62 ± 0.07, 1.75 ± 0.90 & 1.82 ± 0.39) and Adhikari (2021) [1] (1.33 ± 0.17, 1.29 ± 0.07 & 1.50 ± 0.00). In contrast, Kumar (2016) [6] (2.30 ± 0.16, 1.75 ± 0.10 and 2.50 ± 0.27) and Mahla (2018) [7] (2.45 ± 0.11, 2.80 ± 0.09 and 2.75 ± 0.10) reported higher scores. The lack of significant differences in the welfare score of dairy farms of different sizes and regions could be due to the easy availability of similar roofing materials in all regions. Most of the dairy farms had lean-to type of roofing pattern which was adjacent to their house. Asbestos cement sheets, thatch material, tiles and galvanised iron sheets were commonly used as roofing materials. Small farms had lesser roof ridge height i.e., less than 12 ft. which is prescribed by the BIS; this was adequate given the few numbers of animals reared. However, large dairy farms had the highest scores, due to superior roofing materials and higher ridge height.

Type of floor: The mean scores in small, medium and large dairy farms, out of total score of 2, were 0.53 ± 0.085, 0.68 ± 0.116 and 0.90 ± 0.112, respectively, with an overall welfare score of 0.70 ± 0.063. The mean welfare score of this indicator in large dairy farms was significantly ($P<0.05$) higher than small dairy farms, primarily due to better flooring type, bedding material and floor surface in the large farms. Similar findings in small, medium and large dairy farms were reported by Rajpoot (2019) [8] (0.97 ± 0.02, 0.92 ± 0.08 and 1.06 ± 0.10) and Mahla (2018) [7] (0.90 ± 0.18, 1.10 ± 0.18 and 0.70 ± 0.11), whereas Kumar (2016) [6] (1.15 ± 0.13, 1.40 ± 0.27 and 1.40 ± 0.22) and Adhikari (2021) [1] (1.11 ± 0.11, 1.64 ± 0.17 & 2.00 ± 0.00) reported higher scores with significant differences. The welfare score had no significant difference because majority of the farmers in the study area had stone floor type as stone was abundantly available due to granite mining in the region and it was more economical to the farmers. Most of the large farmers used rubber mats which were supplied by the cooperative societies at subsidized prices. But small farmers were unaware of bedding material, so lower mean welfare scores were observed. In most farms, the floor was non-slippery due to proper cleaning and regular drying of the floor.

Microclimate protection measures: The mean welfare scores in small, medium and large dairy farms, out of total score of 5, were 1.95 ± 0.246, 1.60 ± 0.285 and 1.65 ± 0.167, respectively, with an overall welfare score of 1.73 ± 0.136, and no significant difference between the groups. In contrast, Kumar (2016) [6] (2.93 ± 0.34), Mahla (2018) [7] (2.90 ± 0.21) and Rajpoot (2019) [8] (2.40 ± 0.10) reported higher overall scores with significantly higher welfare in large farms. The better welfare scores of small dairy farms were due to presence of shady trees in open area and keeping cows in the open area during day time. However, large dairy farms had ceiling fans and practiced water spraying in the day time to maintain homeostasis.

Feeding & watering space availability: The mean welfare scores in small, medium and large dairy farms, out of total score of 5, were 3.70 ± 0.128, 3.95 ± 0.050 and 4.00 ± 0.073, respectively, with an overall welfare score of 3.88 ± 0.054. Large dairy farms were significantly (P<0.05) better than the small dairy farms in this indicator, primarily due to better feeder space, feeding area hygiene and watering system. Similar findings with Adhikari (2021) [1] (2.78 ± 0.28, 3.39 ± 0.33 & 5.00 ± 0.00), Rajpoot (2019) [8] (2.08 ± 0.16, 2.58 ± 0.16 & 2.65 ± 0.19), Kumar (2016) [6] (1.90 ± 0.27, 1.90 ± 0.31 & 2.80 ± 0.47) and Mahla (2018) [7] (3.30 ± 0.16, 3.10 ± 0.10 & 3.40 ± 0.18). In most of the dairy farms, water was not always available.

Milking system: The mean scores in small, medium and large dairy farms, out of total score of 5, were 2.10 ± 0.069, 2.35 ± 0.109 and 2.85 ± 0.082, respectively, with an overall welfare score of 2.43 ± 0.065. Large dairy farms had significantly (P<0.05) higher welfare scores than the small and medium farms in this indicator, primarily due to better milking technique and greater adoption of machine milking. This was indicative of the fact that herd size increases, dairy farms converted from manual milking to mechanized milking for better management. All the farms had comparable standards with regard to milking equipment hygiene and sanitation and udder cleaning. However, very few farms practiced teat disinfection and utilisation of separate milking parlour. Kumar (2016) [6] (1.40 ± 0.18, 2.10 ± 0.22 and 3.10 ± 0.43), Adhikari (2021) [1] (1.28 ± 0.22, 2.51 ± 0.59 and 3.00 ± 0.00) and Mahla (2018) [7] (1.00 ±0.00, 1.50 ± 0.29 and 2.70 ± 0.44) also reported significant differences in milking system between large and small farms. In contrast, Rajpoot (2019) [8] (1.15 ± 0.86, 1.00 ± 0.00 and 1.00) found no significant differences in Uttar Pradesh.

Table 1: Mean welfare score of 'Housing and other facilities' component in dairy farms of different size

Welfare indicator	Max Score	Farm size			Overall	P-value
		Small	Medium	Large		
Housing type & space availability	10	6.53^a± 0.414	5.75^{ab} ± 0.479	4.75^b ± 0.360	5.68 ± 0.257	0.016
Type and height of roof	3	1.53 ± 0.128	1.60 ± 0.134	1.85 ± 0.109	1.66 ± 0.073	0.162
Type of floor	2	0.53^a ± 0.085	0.68^{ab} ± 0.116	0.90^b ± 0.112	0.70 ± 0.063	0.048
Microclimate protection measures	5	1.95 ± 0.246	1.60 ± 0.285	1.65 ± 0.167	1.73 ± 0.136	0.533
Feeding & watering space availability	5	3.70^a ± 0.128	3.95^{ab} ± 0.050	4.00^b ± 0.073	3.88 ± 0.054	0.047
Milking system	5	2.10^a ± 0.069	2.35^a ± 0.109	2.85^b ± 0.082	2.43 ± 0.065	0.000
Total score	30	16.33 ± 0.671	15.93 ± 0.719	16.00 ± 0.429	16.08 ± 0.352	0.889

Note: Means within a row bearing different superscripts differ significantly (P<0.05).

Table 2: Mean welfare score of sub-components of 'Housing and other facilities' in dairy farms of different sizes and regions

Sl.	Welfare indicator	Max Score	Farm size			Overall
			Small farms	Medium farms	Large farms	
1	Housing type & space availability	10	6.53 ± 0.414	5.75 ± 0.479	4.75 ± 0.360	5.68 ± 0.257
	Type of housing	3	2.35 ± 0.109	2.30 ± 0.105	2.05 ± 0.050	2.23 ± 0.055
	Covered area	3	1.50 ± 0.235	0.95 ± 0.246	0.60± 0.210	1.02 ± 0.140
	Open area	2	0.90 ± 0.161	0.75 ± 0.176	0.30 ± 0.128	0.65 ± 0.095
	Ventilation	1	0.93 ± 0.041	0.88 ± 0.050	0.90 ± 0.046	0.90 ± 0.026
	Light	1	0.85 ± 0.073	0.88 ± 0.050	0.90 ± 0.046	0.88 ± 0.033
2	Type and height of roof	3	1.53 ± 0.128	1.60 ± 0.134	1.85 ± 0.109	1.66 ± 0.073
	Roof material	2	1.25 ± 0.099	1.30 ± 0.105	1.45 ± 0.114	1.33 ± 0.061
	Roof ridge height	1	0.28 ± 0.077	0.30 ± 0.056	0.40 ± 0.046	0.33 ± 0.035
3	Type of floor	2	0.53 ± 0.085	0.68 ± 0.116	0.90 ± 0.112	0.70 ± 0.063
	Flooring type	1	0 ± 0	0.10 ± 0.069	0.10 ± 0.069	0.07 ± 0.032
	Bedding material	0.5	0.15 ± 0.053	0.20 ± 0.056	0.35 ± 0.053	0.23 ± 0.032
	Floor surface	0.5	0.38 ± 0.050	0.38 ± 0.050	0.45 ± 0.034	0.40 ± 0.026
4	Microclimate protection measures	5	1.95 ± 0.246	1.60 ± 0.285	1.65 ± 0.167	1.73 ± 0.136
	Evaporative cooling system	1	0 ± 0	0 ± 0	0 ± 0	0 ± 0
	Fans	1	0.10 ± 0.069	0.25 ± 0.099	0.45 ± 0.114	0.27 ± 0.058
	Bathing in the day time	1	0.60 ± 0.112	0.65 ± 0.109	0.90 ± 0.069	0.72 ± 0.059
	Keeping cows in open area during day time	1	0.65 ± 0.109	0.40 ± 0.112	0.15 ± 0.082	0.40 ± 0.064
	Shady trees in an open area	1	0.60 ± 0.112	0.30 ± 0.105	0.15 ± 0.082	0.35 ± 0.062
5	Feeding & watering space availability	5	3.70 ± 0.128	3.95 ± 0.050	4.00 ± 0.073	3.88 ± 0.054
	Feeder space	1	0.90 ± 0.069	1.00 ± 0.000	0.95 ± 0.050	0.95 ± 0.028
	Feeding area hygiene	1	0.80 ± 0.092	0.95 ± 0.050	1.00 ± 0.000	0.92 ± 0.036
	Waterer space	1	1.00 ± 0.000	1.00 ± 0.000	1.00 ± 0.000	1.00 ± 0.000
	Watering system	1	0 ± 0	0 ± 0	0.05 ± 0.050	0.02 ± 0.017
	Watering area hygiene	1	1.00 ± 0.000	1.00 ± 0.000	1.00 ± 0.000	1.00 ± 0.000
6	Milking system	5	2.10 ± 0.069	2.35 ± 0.109	2.85 ± 0.082	2.43 ± 0.065
	Separate milking parlour	1	0 ± 0	0.05 ± 0.050	0 ± 0	0.02 ± 0.017
	Milking technique	1	0.10 ± 0.069	0.30 ± 0.105	0.85 ± 0.082	0.42 ± 0.064
	Fresh water for washing udder and cleaning	1	1.00 ± 0.000	1.00 ± 0.000	1.00 ± 0.000	1.00 ± 0.000
	Teat disinfection	1	0 ± 0	0.05 ± 0.050	0 ± 0	0.02 ± 0.017
	Milking equipment Hygiene and sanitation	1	1.00 ± 0.000	0.95 ± 0.050	1.00 ± 0.000	0.98 ± 0.017
	Total score	30	16.33 ± 0.671	15.93 ± 0.719	16.00 ± 0.429	16.08 ± 0.352

Conclusion
The study revealed that dairy housing welfare scores in Karnataka varied with farm size. Small farms scored significantly higher in housing type and space availability due to better ventilation and loose housing systems. In contrast, large farms performed better in flooring, feeding and watering space, and milking systems owing to better infrastructure and mechanization. However, no significant differences were observed in overall housing welfare scores across farm sizes. While small farms benefited from traditional practices and natural resources, large farms leveraged modern facilities. This highlights the need for tailored interventions that balance infrastructure improvements with traditional strengths across all farm sizes.

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