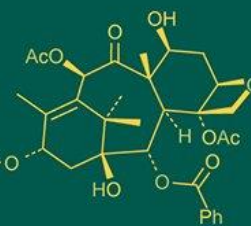
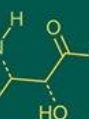
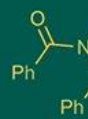


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Assessment of animal welfare status of livestock farming systems in Nagpur District of Maharashtra (India)

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Abstract

In the evolving dairy landscape in Nagpur district of Vidarbha region of Maharashtra state, animal welfare remains a critical yet under-investigated domain. This study explores the relationship between Livestock Farming Systems (LFS) and key animal welfare indicators, with a primary focus on lameness. Data collected from ten tehsils of Nagpur district between June 2025 and January 2026 revealed that while large-scale operations possess superior infrastructure, they do not necessarily translate to better animal-based health outcomes. The pooled average welfare score was 55.128 ± 0.556 , indicating a moderate welfare status across the district. Statistical analysis showed no significant difference in lameness prevalence across farm sizes, however highlighted a potent correlation between floor cleanliness ($r = 0.371$, $p < 0.01$). These results suggest that the micro-environment of the shed, rather than the macro-scale of the farm, is the ultimate arbiter of dairy cow welfare.

Keywords: Animal welfare, livestock farming systems, floor cleanliness score, lameness

Introduction

As dairy farming has scaled up to meet global demand, cow welfare has become a major concern rather than just an afterthought (Fraser, 2008) ^[14]. Today, animal welfare is essential for farm productivity, as healthy cows thrive while poor conditions cause disease and heavy financial losses (Broom, 2010). Good welfare means a cow is physically and emotionally well, and protected from pain and distress by the "Five Freedoms" Freedom from hunger and thirst, freedom from pain, injury and disease, Freedom from distress, Freedom from discomfort, Freedom to express behaviours that promote well-being. To measure this, modern farms evaluate both the environment, such as stall design, and the cow herself, focusing heavily on her hygiene and mobility (Blokhuis *et al.*, 2010). Lameness stands out as one of the most painful and serious welfare issues a cow can face (OIE, 2019). Characterized by an abnormal gait due to foot or leg pain, it acts as a massive red flag indicating poor housing or unhygienic management (Cook, 2003) ^[10]. The fallout is incredibly costly for the farm, leading to a drop in milk production, breeding problems, and early culling. Even slight limps increase a cow's stress and alter how she eats and rest, deeply compromising her overall quality of life (Whay *et al.*, 2003). This painful condition is typically triggered by hard concrete floors, poor stalls, and wet, filthy environments that soften hooves and breed the infectious bacteria (Cook & Nordlund, 2009) ^[11]. The cleanliness of a dairy farm's flooring plays a massive role in the hoof health and overall mobility of the herd. When alleys and stalls are poorly managed, cows end up standing in wet manure and slurry, which physically softens their hooves and creates a perfect breeding ground for painful, infectious foot diseases (Cook, 2002). Farms with dirtier floors consistently record much higher locomotion scores, meaning more of their cows are visibly struggling to walk (Kara *et al.*, 2011). Because of this strong link, keeping floors clean and dry isn't just about farm aesthetics; it is a critical, everyday necessity for preventing lameness and keeping the animals comfortable and productive (Relun *et al.*, 2013). Dairy farms across India differ hugely in size, available resources and management styles. Small family-run farms usually stick to traditional housing, medium farms act as a middle ground with some improved

Practices, and large commercial operations rely on fully mechanized systems (Birthal and Taneja, 2006; NDDDB, 2022). Each setup impacts cow welfare in its own unique way. For instance, cows on smaller farms benefit from highly personalized care, but they might suffer because the farm lacks the budget for good infrastructure like proper drainage (Birthal and Taneja, 2006). On the flip side, larger farms might boast better facilities, but they struggle with overcrowding and can't monitor individual animals as closely (Barkema *et al.*, 2015) ^[1].

Despite these clear differences, developing countries are still missing broad research that connects farm size to daily realities like housing, hygiene, and hoof health (WOAH, 2019). The Nagpur district in Maharashtra is a perfect place to fill this gap because it hosts such a diverse mix of farm sizes, management routines and farmer backgrounds. Comparing small, medium, and large operations here will help us figure out if scaling up a farm actually improves welfare or just introduces new stress factors. Furthermore, if the data shows a strong link between poor living conditions and lameness, it reinforces the idea that simply evaluating how a cow walks is a highly reliable way to check her overall well-being in the field (Whay *et al.*, 2003). Ultimately, the dairy industry can only thrive long-term if it balances milk production with genuine animal care (Broom, 2010). That is exactly why this study was conducted to evaluate how everyday farming conditions directly affect cow welfare and mobility

Methodology

Location of the study: This research was conducted in and around the Nagpur district, located centrally on the Deccan Plateau in the Vidarbha region of Maharashtra. Widely known as the "Orange City" for its agricultural trade

Sampling method: To get an accurate picture of the region's dairy landscape, the farms were selected using a stratified sampling method across ten different tehsils including Bhivapur (2), Hingana (9) Kalmeshwar (21),

Kamptee (29), Katol (19), Kuhi (2), Mauda (2), Nagpur (2), Parshivni (2) and Umred (6) to capture both rural and peri-urban practices, total number of LFS under study was 94. The livestock farming systems were divided into three specific groups based on their total herd size: Small holders: <10 to 19> animals, Medium holders: 20 to 49 animals and Large holders: 50 < animals.

Data collection process

Information was gathered directly on the LFS through a combination of farmer interviews and hands-on observations. The research team measured the physical infrastructure of each farm, recording the dimensions of housing, as well as the space allocated for resting, feeding, watering, and milking. Alongside these environmental measurements, the researchers conducted on-the-spot evaluations of the cattle, scoring them on critical welfare indicators like lameness, body condition, overall hygiene, floor cleanliness, hock injuries and behavioural abnormalities.

Assessing dairy cattle welfare

To systematically evaluate the animals' well-being, the study utilized the Dairy Cattle Welfare Scale (DCWS), which was specifically adapted to suit Indian farming conditions (Kamboj and Kumar, 2016). Built upon an earlier integrated diagnostic framework, this scale uses 20 specific indicators that align with the globally recognized "Five Freedoms" of animal welfare (Calamari and Bertoni, 2009) ^[6]. To ensure a balanced assessment, these indicators evaluate both the farm's resources and the animals themselves, grouped into three weighted categories: Component A (Housing and Facilities): 6 environmental parameters, contributing up to 30 points. Component B (Feed and Feeding Practices): 4 management parameters, contributing up to 30 points. Component C (Health, Performance, and Behaviour): 10 direct, animal-based parameters, contributing up to 40 points.

Table 1: Component of Dairy Cattle Welfare Scale (DCWS)

Components	Indicators	Score
A. Animal Housing and Other facilities (30)	1. System of housing & availability of floor space	10
	2. Type & height of roof	3
	3. Types of floor	2
	4. Microclimate protection measures	5
	5. Feeding and Watering space availability feeding and watering systems with frequency	5
	6. Availability of milking parlour/ separate milking place, water for bathing cows, udder washing, cleaning of milking utensils and availability of lighting	5
B. Feeds and Feeding practices (30)	7. Availability of feed & Fodder	10
	8. Availability of feeds and fodder storage/ prevention space	5
	9. Feeding practice of different categories of animals	10
	10. Colostrum and feeding of milk to calves.	5
C. Animal Health Performance and Behaviour (40)	Average productivity (AP)	8
	Body condition score (BCS)	4
	Cow Comfort Index (CCI)	5
	Cow Cleanliness Score (CCS)	4
	Hock injury Score (HIS)	3
	Human animal Interaction (HAR)	3
	Lameness Score (LS)	4
	Mastitis Incidence (MI)	4
	Reproductive Efficiency (RE)	3
	Abnormal behaviours (AB)	2

Classifying farm welfare

To figure out exactly where each farm stood, the individual welfare indicators were totalled up to create an overall score. Farms scoring above 80 earned a Rank 1 for "Excellent" welfare. Scores between 60 and 79 received a Rank 2 for "Good," while 40 to 59 landed in Rank 3 for "Average or Moderate." Any farm scoring below 40 was given a Rank 4, indicating "Poor" living conditions.

Assessing lameness

To check the cows' mobility, the study used the widely trusted five-point scoring system created by Flower and Weary (2006) ^[13]. Cow walk was observed at a normal pace

across a flat, non-slip surface, looking closely at her back posture and stride to spot any discomfort. Cows scoring a 1 or 2 were classified as non-lame. A score of 1 means the cow is completely sound with a level back and fluid strides, while a 2 indicates an imperfect gait where the back arches slightly only when walking.

Cows scoring between 3 and 5 were classified as lame. A 3 means mild lameness with a consistent back arch and a slight limp. A score of 4 points to moderate lameness, marked by short, stilted steps and a heavily arched back, finally, a 5 represents severe lameness, where the cow is extremely hesitant to move and might completely refuse to put weight on one of her legs.

Table 2: The Lameness Score in cows recorded as per (Flower and Weary 2006) ^[13]

Score	Description of Gait and Posture
1 - Sound	The cow walks with a level back, showing long, fluid strides. All limbs bear weight evenly, and the hind feet land in or in front of the prints of the forefeet.
2- Imperfect Gait	The back is flat when standing but may show a slight arch when walking. Strides are slightly shortened, but the cow still tracks up (hind feet land near forefeet prints).
3- Mildly Lamé	A consistent arch is visible in the back during both standing and walking. The cow shows a slight "abnormal" gait, often favoring one limb, and stride length is noticeably reduced
4 - Moderately Lamé	The back is markedly arched. The cow is clearly hesitant to move and avoids bearing full weight on one or more affected limbs. Steps are short and "stilted"
5- Severely Lamé	The cow is extremely reluctant to move. It may refuse to bear any weight on one limb (three-legged gait) and exhibits a pronounced arched back at all times.

Evaluating floor cleanliness

To measure shed hygiene, the study relied on a four-point scale based on a Dairy Research Cleanliness Cluster Report 2011, which simply looks at the thickness of manure on the floor. A score of 0 means the floor is clean with barely a film of manure (under 0.5 cm), and a 1 means it is just a bit dirty with up to 1 cm of manure. These two were grouped together as the "Clean" category. On the flip side, a score of 2 means the floor is distinctly dirty with a 1 to 3 cm layer of manure. A 3 means the floor is very dirty, with manure over 3 cm thick enough to cover the toes of your rubber boots. Scores of 2 and 3 were grouped together as the "Dirty" category.

Statistical analysis

To make sense of all these observations, the data was analyzed using a suitable statistical procedure. The SPSS 20 software package was used to crunch the numbers, calculate standard errors and determine which findings were statistically significant.

Results and discussion

Welfare component scores

Component A: Out of a possible 30 points, the mean scores were 10.130 ± 0.746 for small, 10.490 ± 0.506 for medium and 13.455 ± 0.509 for large farms, with a pooled average of 11.096 ± 0.368 . Large farms scored significantly higher because they have the budget for scientific infrastructure, while small farms rely on traditional setups. Overall, housing scored the lowest of all components, showing a region-wide lack of investment in proper facilities. The above observed results similar to previous studies (Deb *et al.*, 2025; Sumer *et al.*, 2024) ^[12] whereas, others studies reported different rankings (Mahla, 2018; Chandan, 2017; Kamboj and Kumar (2016) ^[19]. Component B: Out of 30 scores were 19.826 ± 0.673 for

Small, 19.980 ± 0.440 for medium, and 22.364 ± 0.277 for large LFS, with a pooled mean of 20.500 ± 0.309 . Again, large LFS performed significantly better. Farmers generally prioritize feeding over housing because it directly impacts milk yield. This trend aligns with several past studies (Chandan *et al.*, 2017; Mahla, 2018; Kamboj and Kumar (2016), while others found medium farms scoring highest (Sumer, 2024; Deb *et al.*, 2025) ^[12, 18, 19].

Component C: Interestingly, the trend flipped here. Out of 40 scores were 24.348 ± 0.367 for small, 23.449 ± 0.278 for medium, and 22.864 ± 0.437 for large LFS, with a pooled score of 23.532 ± 0.206 . Small LFS scored significantly higher because fewer animals mean farmers can closely observe behaviour and catch diseases early. Large LFS struggle with this individual attention. This mirrors findings by Chandan (2017) and Kamboj and Kumar (2016), though Mahla (2018) ^[18, 19] and Sumer *et al.* (2024) reported higher overall scores. Notably, no farm size achieved a perfect score.

Overall welfare and rankings

Total Score: Out of 100, large LFS led the overall welfare scores at 58.682 ± 0.669 , followed by small (54.304 ± 1.177) and medium (53.918 ± 0.769) LFS with a pooled mean of 55.128 ± 0.556 . Large LFS won out largely due to better financial resources. This agrees with several researchers (Sumer *et al.*, 2024; Kumar *et al.*, 2025; Chandan *et al.* 2017) ^[7, 16], though others found medium LFS performing best (Deb *et al.*, 2025) ^[12] or saw higher general averages (Kamboj and Kumar (2016; Mahala, 2018).

Welfare Rank: The mean ranks were 2.870 ± 0.070 for small, 2.837 ± 0.053 for medium and 2.591 ± 0.105 for large LFS (pooled 2.782 ± 0.042). This indicates the vast majority of LFS fall into an "Average" welfare status, though large LFS rank slightly better, which aligns with previous observations (Sumer *et al.*, 2024; Deb *et al.*, 2025) ^[12].

Table 3: Average±SE of component wise welfare score among different LFS

	Total Component A Score	Total Component B Score	Total Component C Score	Total Component Score	Welfare Rank of Farm
Small	10.130±0.746 ^b	19.826±0.673 ^b	24.348±0.367 ^a	54.304± 1.177 ^b	2.870± 0.070 ^a
Medium	10.490±0.506 ^b	19.980±0.440 ^b	23.449±0.278 ^{ab}	53.918± 0.769 ^b	2.837± 0.053 ^a
Large	13.455±0.509 ^a	22.364±0.277 ^a	22.864±0.437 ^b	58.682± 0.669 ^a	2.591± 0.105 ^b
Pooled	11.096±0.368	20.500±0.309	23.532± 0.206	55.128±0.556	2.782±0.042

Lameness and floor cleanliness in different lfs

The mean Lameness score was lowest on small LFS (1.140±0.119), followed by medium (1.172±0.035), and highest on large LFS (1.243±0.025), with a pooled score of 1.181±0.021 (ranging from 1.000 to 2.818). While severe lameness was rare, mild lameness was common everywhere, especially on large LFS due to overcrowding and hard concrete floors. Similar mild lameness values were reported in other Indian farms (Patoliya *et al.*, 2024).

Floor Cleanliness Score (FCS) was 1.174±0.146 for small, 1.388±0.122 for medium and 1.227±0.169 for large LFS, with a pooled average of 1.297±0.083. Smaller LFS had the cleanest floors simply because they have less manure and a smaller area to manually clean. As herd sizes grow, keeping floors dry becomes much harder (Brenninkmeyer *et al.*, 2016) [3].

Correlations among components of overall welfare Housing (Component A) is a massive driver of the Total Welfare Score ($r = 0.750$, $p < 0.01$), echoing findings that infrastructure dictates a farm's overall quality (Barker *et al.*, 2007) [2]. Feeding (Component B) was the second biggest contributor ($r = 0.666$, $p < 0.01$), supporting the idea that nutrition is a welfare cornerstone (Broom, 2010). Health and

behaviour (Component C) showed a moderate correlation ($r = 0.362$, $p < 0.01$), which is typical for individual animal indicators (Bruijn *et al.*, 2012) [5].

Correlations among lameness and welfare: Lameness showed a significant positive correlation with Component B ($r = 0.220$, $p < 0.05$) and Total Welfare ($r = 0.246$, $p < 0.05$), and a negative correlation with Welfare Rank ($r = -0.215$, $p < 0.05$). This confirms that as lameness increases, overall farm welfare significantly drops (Whay *et al.*, 2003; Sogstad *et al.*, 2005; Souza and Daros, 2025). However, some past studies found a stronger link between housing and lameness than observed here (Barker *et al.*, 2007; Cook, 2003; Bruijn *et al.*, 2012) [5].

Correlations lameness & floors cleanliness score: There was a highly significant correlation between the Lameness Score and Floor Cleanliness Score ($r = 0.371$, $p < 0.01$). Wet, dirty floors soften hooves and cause lesions, making hygiene a primary risk factor for lameness (Cook, 2002; Schreiner and Ruegg, 2003; Leach *et al.*, 2010; Cook and Nordlund, 2009; Chaudhary *et al.*, 2020) [8, 9, 11, 17]. Cows even change their gait on dirty floors to avoid slipping (Telezhenko, E. and Bergsten, C. (2005).

Table 4: Correlation among lameness and animal welfare, CCS and FCS

	A	B	C	D	E	F	G
A	1						
B	0.200	1					
C	0.220*	0.169	1				
D	-0.023	-0.013	0.000	1			
E	0.246*	0.750**	0.666**	0.362**	1		
F	-0.215*	-0.562**	-0.452**	-0.291*	-0.730**	1	
G	0.371**	0.108	0.140	-0.170	0.080	-0.001	1

* Correlation is significant at the 0.05 level (2 tailed). ** Correlation is significant at 0.01 levels (2 tailed).

A - Lameness Score, B -Component A, C- Component B, D- Component C, E - Total Welfare Score, F - Welfare Rank, G - Floor Cleanliness Score

**Fig 1:** Large farms had the highest welfare score in Nagpur district



Fig 2: Small farms had the highest welfare rank in Nagpur district

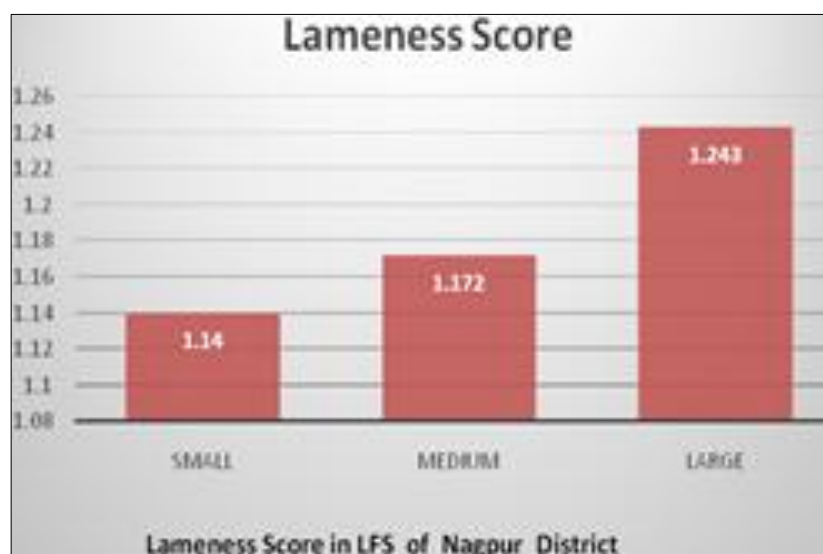


Fig 3: Variation in Lameness Score across Farm Sizes”

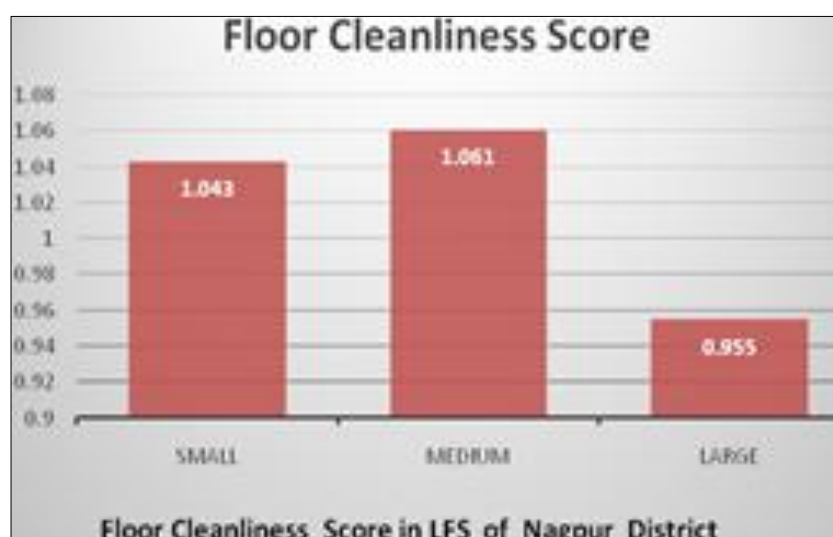


Fig 4: Floor cleanliness score (LFS)

Conclusions

While dairy farming in Nagpur district of Maharashtra state is scaling up, a cow's basic welfare needs remain the same in three types of LFS. The present study reveals that what kinds of measures taken by small LFS were remain same for middle and large LFS. There was no difference found. Large LFS offer structural perks but struggle to monitor individual

health. The data clearly shows that a shed floor is the foundation animal welfare; until cattle are kept off filthy surfaces, lameness will persist. To reduce lameness, farmers should upgrade to grooved or rubber-matted floors with a drainage slope. Routine floor scraping must be treated as preventative medicine to lower cleanliness scores. Furthermore, large commercial herds need formal, monthly

gait-scoring to catch sub-clinical lameness early. Future research should focus on the economic costs which were burden of poor welfare. For this it is imperative to motivate farmers to adopt the better animal welfare practices.

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