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Role of management in dairy udder health

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Abstract
Dairy farmers require animals that are healthy and productive. Udder health is vital for optimum production. The importance of proper management in maintaining udder health cannot be overstated. The somatic cell count and microbiological qualities of milk are indicative of milk quality. The study comprised an assessment of hygienic standards of udder and milk of dairy animals, raised under different managemental practices. A total of 30 households keeping dairy animals (herd size >10) were selected for the collection of information on managemental practices. These households were randomly selected and spanned over 13 villages and peri-urban areas. A total of 100 milk samples were obtained from these selected families to examine the physicochemical and microbiological properties of milk. The standard plate count and coliform count of all milk samples was determined using standard technique. Udder hygiene score was satisfactorily fair (66.10%) in the sampled animals which had significant association (p<0.01) with with Standard Plate Count and Coliform Count.

Keywords: Management, dairy udder health, microbiological

Introduction
Livestock production, particularly the dairy sector is the backstay of rural livelihood in several countries including India. Appropriate care, management and protection of livestock are the major factors contributing to animal production and productivity. Udder health is one of the most important traits of bovine health and is directly related to the quality and quantity of milk produced. Proper udder hygiene is the first step in the production of clean milk. A healthy udder is indicative of a low incidence of clinical mastitis, subclinical mastitis and low somatic cell count [1]. Udder health thus plays a major role in the welfare, production and sustainability of a herd. The infected udder is considered as the primary reservoir of pathogens, that could be transmitted to other animals and humans via contaminated teat liners, milker's hands and communal clothes [2]. Studies have reported that the incidence of sub-clinical mastitis (SCM) ranged from 19.20 to 83 percent in cows [3]. In India, about 70-80 percent of production losses have been attributed to sub-clinical mastitis [4]. Sub-clinical mastitis SCM can cause economic losses in the range of INR 21,677-88,340 for a single lactation period depending on the condition of the animal [5]. A recent study revealed SCM associated economic loss of INR 7824 per month per cow [6]. Sub-optimal udder health is associated with significant costs [7] and increased risk of antibiotic residue violation, as a result of increased antibiotic usage [8].
Proper management is an important aspect to sustain the health of animals. Improper udder hygiene affects the microbiological, physical and chemical properties of milk. Somatic cells such as mammary epithelial cells are implicated in protecting the mammary gland from infection as part of the innate immune response. Thus the amount of somatic cell count in milk is an important indicator of udder health. The Standard Plate Count (SPC) of raw milk revealing the total number of aerobic bacteria in the milk at the time of milking is indicative of the microbiological properties of milk. The presence of coliform bacteria in milk is an indication of poor hygiene. Coliform bacteria are mostly sourced from unhygienic surroundings that contribute to poor udder hygiene scores. Monitoring these parameters could be advantageous for evaluating the managemental conditions of any herd.

Material and Methods
A total of 30 households keeping dairy animals (herd size >10) were selected for the collection of information on management practices. These households were randomly selected and spanned over 13 villages and peri-urban areas (Agra Chak, Suchetgarh, Gagain, Kullian, Kotli Arjun Singh, Nanak Nagar, Channi, Bhatindi, Ghagwal, Sidhra, Talab Tillo, R. S. Pura, and Jorha Farm) of Jammu and Samba district.

The data were stratified based on herd size and geographical location.

A well-structured interview schedule was prepared for data collection based on a thorough review of related literature. The interview schedule comprised 39 questions that were predominantly of closed type but also included semi-closed, multiple-choice and open questions. The interview schedule was evaluated by five scientists and pretested on five selected farmers from the non-sampled area for comprehensibility and clarity. The interview schedule incorporated major areas like herd structure, knowledge regarding improved management practices and adoption of improved dairy managemental practices. Face-to-face interviews with the actual keeper of the animal were carried out in local language. Managemental practices were given much emphasis to check their co-relation with the intra-mammary infections, if any, in the following areas like washing of hands before and after milking, method of milking, time of milking, frequency of milking, washing of animal before milking, washing of udder and teat before milking, suckling by the calf, feeding at the time of milking, method of drying the animal, dry cow therapy, housing of animal and bedding.

Each question was assigned a weightage and the responses were scored as 0-4, based on the type of question (0-1 for closed type, 0-4 for multiple choice with 4 being the highest score for best practice). All the scores of a particular respondent were added to deduce a total management score on a scale of 1-10 by using the formula below:

$$TMS = \frac{\text{Total score on answers}}{\text{Full mark of questionnaire}} \times 10$$

TMS stands for total management Score.

To score the hygienic conditions of the udder, the scorecard developed by

[Schreiner and Ruegg 2003] [9] was used.

Sample Collection

To study the physico-chemical and microbiological properties of milk, a total of 100 milk samples were collected from these selected thirty households. Preferences were given to collect milk samples from quarters suspected of infection. In cases, where all animals in the herd were with apparently healthy quarters, the selection of quarter was random for collecting milk samples. The sampling steps included udder preparation, fore-stripping, aseptic collection of milk and transportation of samples to the laboratory under refrigeration. Before collection, the udder was washed with clean water followed by drying with a clean towel. The first four strips of the milk were discarded. Around 10 ml of milk was then collected in a sterile 15 ml conical tube. The samples were kept in an ice box and transported to the laboratory. All the samples were processed for analysis within 24 hours of collection.

Analysis of physico-chemical properties of milk

The physico-chemical parameters (Fat percentage, SNF, and pH) of milk were analysed in an automated milk analyser (IndiFOSS Analytical Pvt Ltd Ahmedabad, Gujarat). Milk density was calculated from lactometer reading using the formula 1+lactometer reading/1000.

The total somatic cell count of all the milk samples was done by Direct Microscopic Somatic Cell Count (DMSCC) method.

Analysis of microbiological properties of milk

Standard plate count (SPC)

The SPC of all milk samples was determined by the standard technique. The plate containing 50-400 colonies was selected for calculation. The SPC was calculated by using below formula:

$$SPC/ml = \frac{\text{CFU counted} \times \text{reciprocal of dilution factor}}{\text{Volume of milk taken (ml)}}$$

The results were then expressed as $\log_{10}$ cfu/ml of sample

Coliform count (CC)

The Coliform count (CC) of all the milk samples was determined using standard techniques. The plate containing 50-400 colonies was selected for calculation. The coliform count was calculated using the below formula:

$$CC/ml \text{ of milk} = \frac{\text{CFU counted} \times \text{reciprocal of dilution factor}}{\text{Volume of milk taken (ml)}}$$

The results were expressed as log10 cfu/ml of sample.

Results and discussion

The subjective evaluation of udder hygiene was assessed by udder hygiene score as described in the materials and methods section. The cleanliness of udder (UHS1-UHS2) was satisfactory in a fair (66.10%) percentage of studied animals. Extremely dirty udder (UHS 4) was found in a low (7.10%) of animals.

Association of udder hygiene and milk composition

The values of milk components *viz.* fat (%), SNF (%), density and pH under the different categories of UHS have been presented in table 1 and figure 1. It was evident that

Udder Hygiene Score (UHS) had no significant effect on the milk composition of the animals. Nonetheless, an increasing trend in milk fat (%) was observed as the udder hygiene score deteriorated. A similar trend was also observed for milk SNF (%), however, no definite trend was observed for milk density or pH with change in UHS.

Table 1: Physico-chemical properties of milk samples vis-a-vis different udder hygiene scores

UHS	Particulars	Fat (%)	SNF (%)	Density	pH
1	Mean	4.349	8.244	1.029	6.738
	SE	0.239	0.068	0.001	0.036
2	Mean	4.370	8.410	1.029	6.750
	SE	0.185	0.074	0.001	0.028
3	Mean	4.480	8.427	1.029	6.680
	SE	0.180	0.075	0.001	0.024
4	Mean	4.833	8.500	1.026	6.633
	SE	0.644	0.252	0.002	0.088

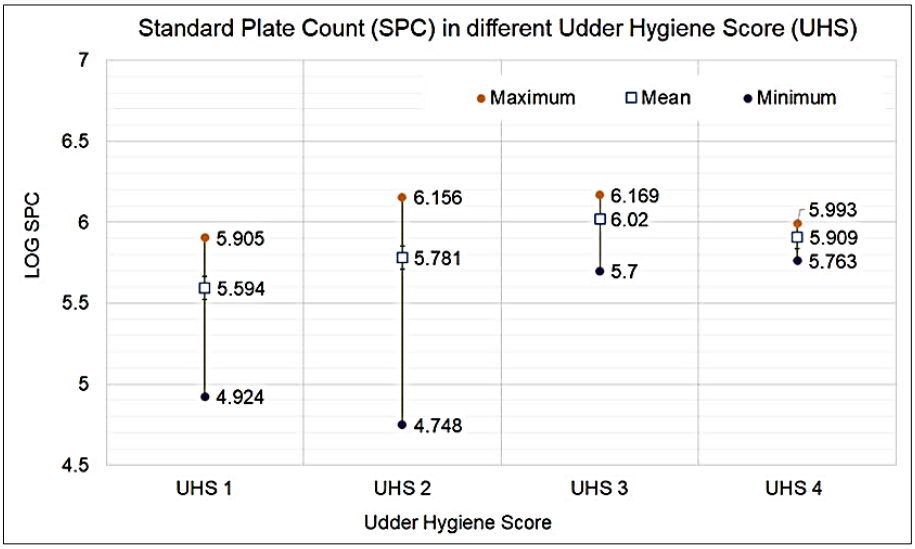
Fig 1: Mean, maximum and minimum values of different milk components under different UHS (A) Fat percent (B) SNF percent (C) Density and (D) pH

Association of udder hygiene with microbiological quality and SCC of milk

The values of SPC, CC and SCC of milk under different category of UHS have been presented in table 2 and figure 2. UHS had significant effect on microbiological quality of milk influencing both SPC and CC. The mean log SPC increased progressively as the udder hygiene score increased. A similar trend was also observed for log CC count in milk and the UHS. However, UHS has no significant association with log SCC of milk. It was found that UHS has significant (p<0.01) correlation with log SPC and log CC (figure 3) When the udder hygiene score was low (1or 2) *i.e.* free from dirt or little dirt (less than 10 percent) attached to rear quarter and udder the standard plate count was also lower. Similar results were found in a study which suggest that cleanliness of the udder has a close association with quantity and type of bacteria present on teat surfaces [10]. Contradictory to present study the poor udder hygiene status was found associated with influx of leucocytes into milk thus increasing SCC in milk [11].

Table 2: Effect of different Udder Hygiene Score on SCC and microbiological quality of milk. Rows with different superscript vary significantly (p<0.05) in their mean values

UHS	Particulars	SPC (log CFU/ml)	CC (log CFU/ml)	SCC (log SCC/ml)
1	Mean	5.594^{a}	3.936^{a}	4.934
	SE	0.069	0.282	0.022
2	Mean	5.781^{b}	4.567^{b}	4.935
	SE	0.070	0.252	0.016
3	Mean	6.020^{c}	4.993^{b}	4.956
	SE	0.027	0.023	0.012
4	Mean	5.909^{bc}	5.050^{b}	4.898
	SE	0.073	0.064	0.025



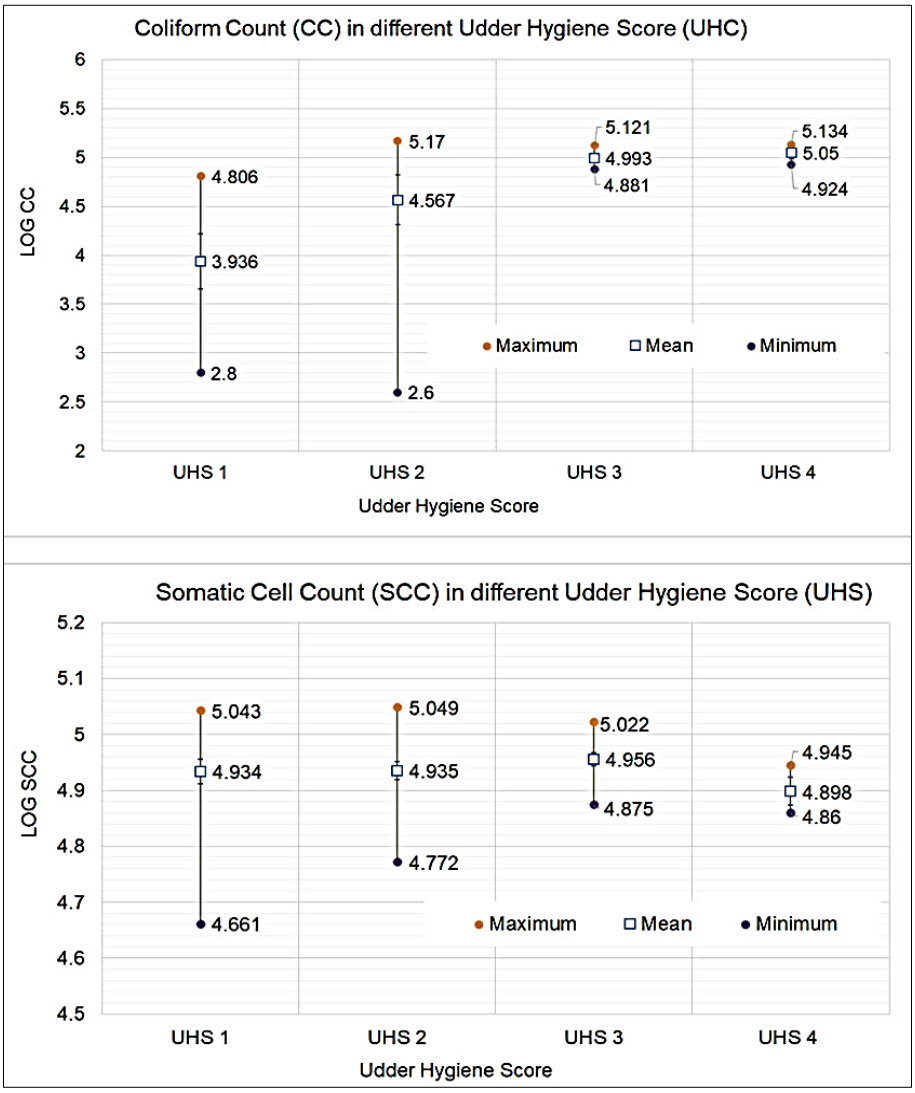


Fig 2: Mean, maximum and minimum values of SPC, CC and SCC of milk under different UHS

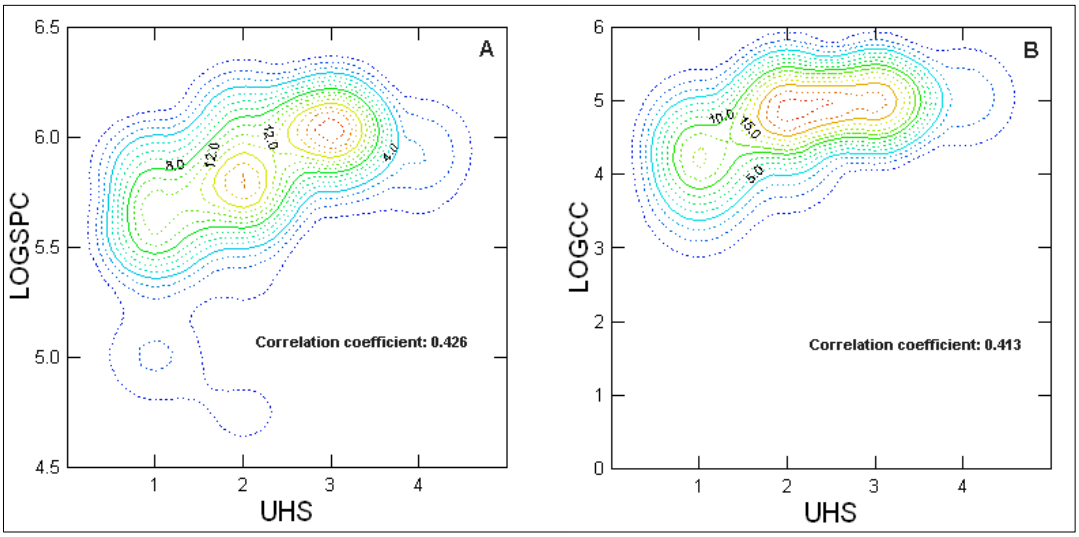


Fig 3: Dot density plot of udder hygiene score and microbiological parameters of milk (A) log SPC (b) log CC

Effect of different managemental parameters on milk composition

The values of milk components viz. fat (%), SNF (%), density and pH under the different categories of managemental practices have been presented in table 3, 4, 5, 6 and 7 and figure 4. It was evident that different managemental practices had no significant effect on the milk composition of the animals. However, washing the animal had a significant effect on milk fat percentage. The mean fat percentage and SNF were lower when the managemental conditions were better. No specific trend was observed in the case of milk density in different managemental conditions. The mean pH remained unaffected by different managemental conditions.

Association of different managemental practices with microbiological quality and SCC of milk

The values of SPC, CC and SCC of milk under different managemental conditions have been presented in tables 3, 4, 5, 6 and 7, and depicted in figure 5. Washing of animals had a significant effect on the microbiological quality of milk influencing both SPC and CC. The mean log SPC decreased with better housing and bedding. Mean log SPC was less in farms where teat dipping was practiced. A similar trend was also observed for log CC count in milk and different managemental practices. However, housing, bedding and teat dipping had no significant association with log SCC of milk. Similarly, it was found that on-farm managemental practices could significantly influence milk quality [12, 13]. Another study revealed that mastitic pathogens could be present on dirty teats and udders thereby increasing the potential risk of intra-mammary infections [14]. Therefore washing of teats should be made common practice. The results are also in accordance with Paul *et al*. (2018) [15] which recommended good udder hygiene management can lessen the chances of infection in animals including mastitis. A study by Robles *et al.* (2020) [11] revealed bedding management could have an impact on milk quality and cow hygiene with lower *Streptococcus* spp. count.

Table 3: Effect of washing of animals on milk parameters (Mean ± SE)

Parameters	Washing of animals			
	No		Yes	
	Mean	SE	Mean	SE
LOGSPC	5.88	0.04	5.69	0.08
LOGCC	4.90	0.05	4.37	0.12
LOGSCC	4.94	0.01	4.92	0.02
FAT	4.09	0.08	4.42	0.16
SNF	8.33	0.05	8.28	0.05
DENSITY	1.03	0.00	1.03	0.00
pH	6.72	0.02	6.70	0.03

Table 4: Effect of dry cow therapy on milk parameters (Mean ± SE) of animals

Parameters	Dry cow therapy			
	No		Yes	
	Mean	SE	Mean	SE
LOGSPC	5.82	0.05	5.68	0.08
LOGCC	4.81	0.05	3.87	0.15
LOGSCC	4.93	0.01	4.95	0.02
FAT	4.18	0.05	4.54	0.48
SNF	8.33	0.03	8.21	0.13
DENSITY	1.03	0.00	1.03	0.00
pH	6.71	0.02	6.71	0.06

Table 5: Effect of different types of housing on milk parameters (Mean ± SE) of animals

Parameters	Housing			
	Kacha		Pacca	
	Mean	SE	Mean	SE
LOGSPC	5.94	0.06	5.74	0.05
LOGCC	4.93	0.08	4.60	0.08
LOGSCC	4.92	0.02	4.94	0.01
FAT	4.15	0.11	4.26	0.11
SNF	8.27	0.07	8.32	0.04
DENSITY	1.03	0.00	1.03	0.00
pH	6.69	0.03	6.72	0.02

Table 6: Effect of different types of bedding on milk parameters (Mean ± SE) of animals

Parameters	Bedding			
	Straw		Rubber mats	
	Mean	SE	Mean	SE
LOGSPC	5.84	0.06	5.70	0.05
LOGCC	4.89	0.05	4.11	0.11
LOGSCC	4.94	0.01	4.93	0.02
FAT	4.17	0.05	4.38	0.27
SNF	8.32	0.04	8.27	0.08
DENSITY	1.03	0.00	1.03	0.00
pH	6.71	0.02	6.72	0.04

Table 7: Effect of teat dip on milk parameters (Mean ± SE) of animals

Parameters	Teat Dip			
	No		Yes	
	Mean	SE	Mean	SE
LOGSPC	5.84	0.06	5.70	0.05
LOGCC	4.89	0.05	4.11	0.11
LOGSCC	4.94	0.01	4.93	0.02
FAT	4.17	0.05	4.38	0.27
SNF	8.32	0.04	8.27	0.08
DENSITY	1.03	0.00	1.03	0.00
pH	6.71	0.02	6.72	0.04

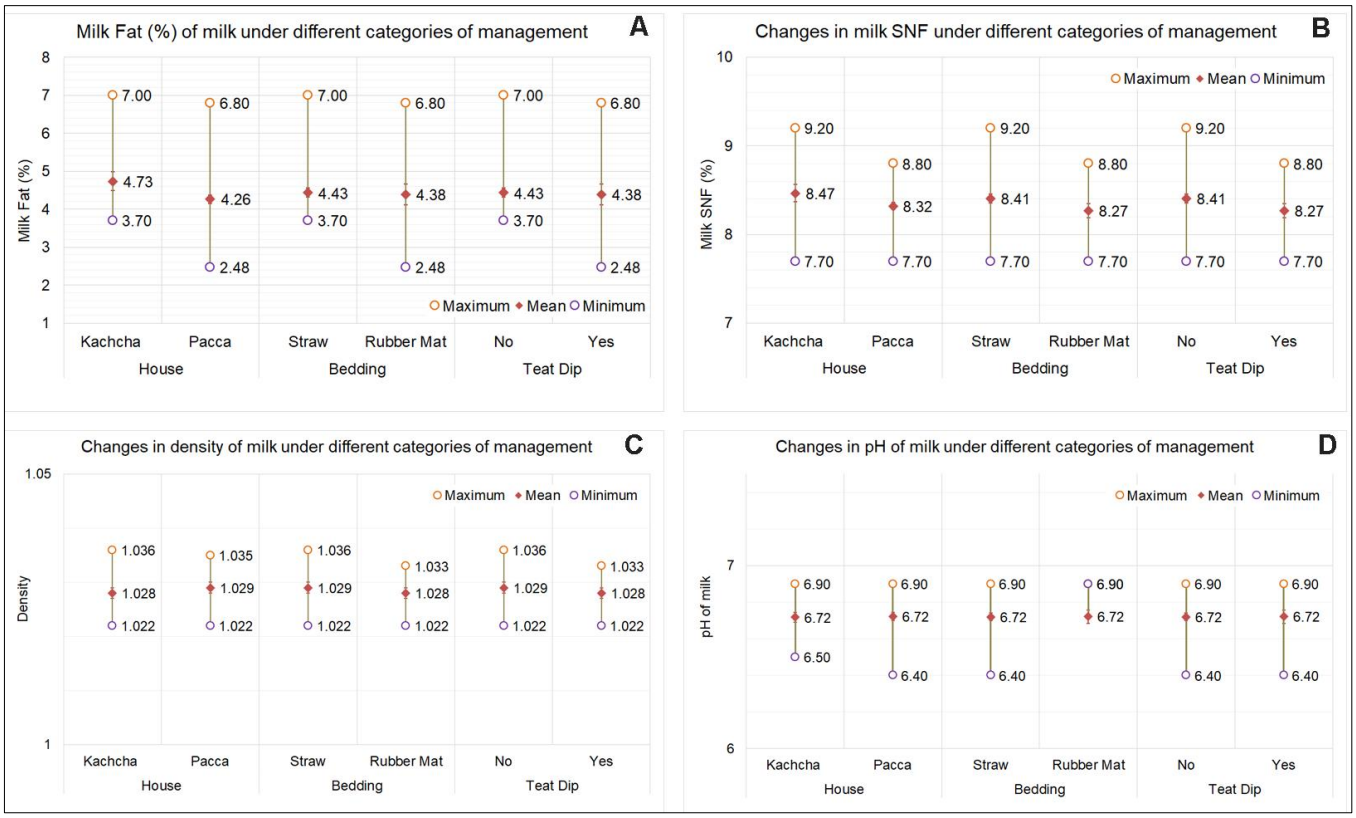
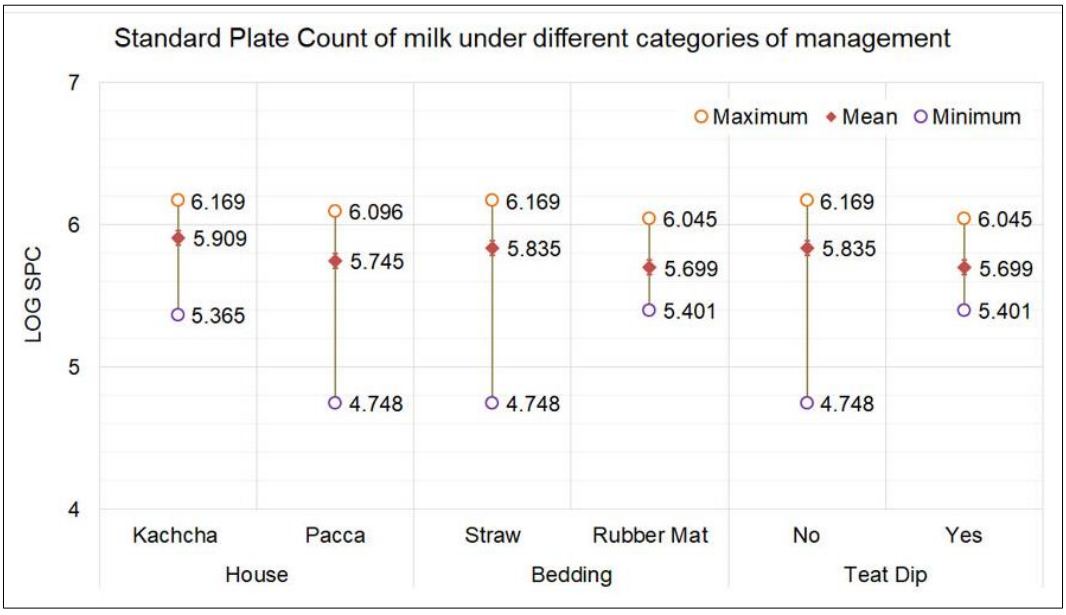


Fig 4: Mean, maximum and minimum values of different milk components under different categories of management (A) Fat percent (B) SNF percent (C) Density and (D) pH



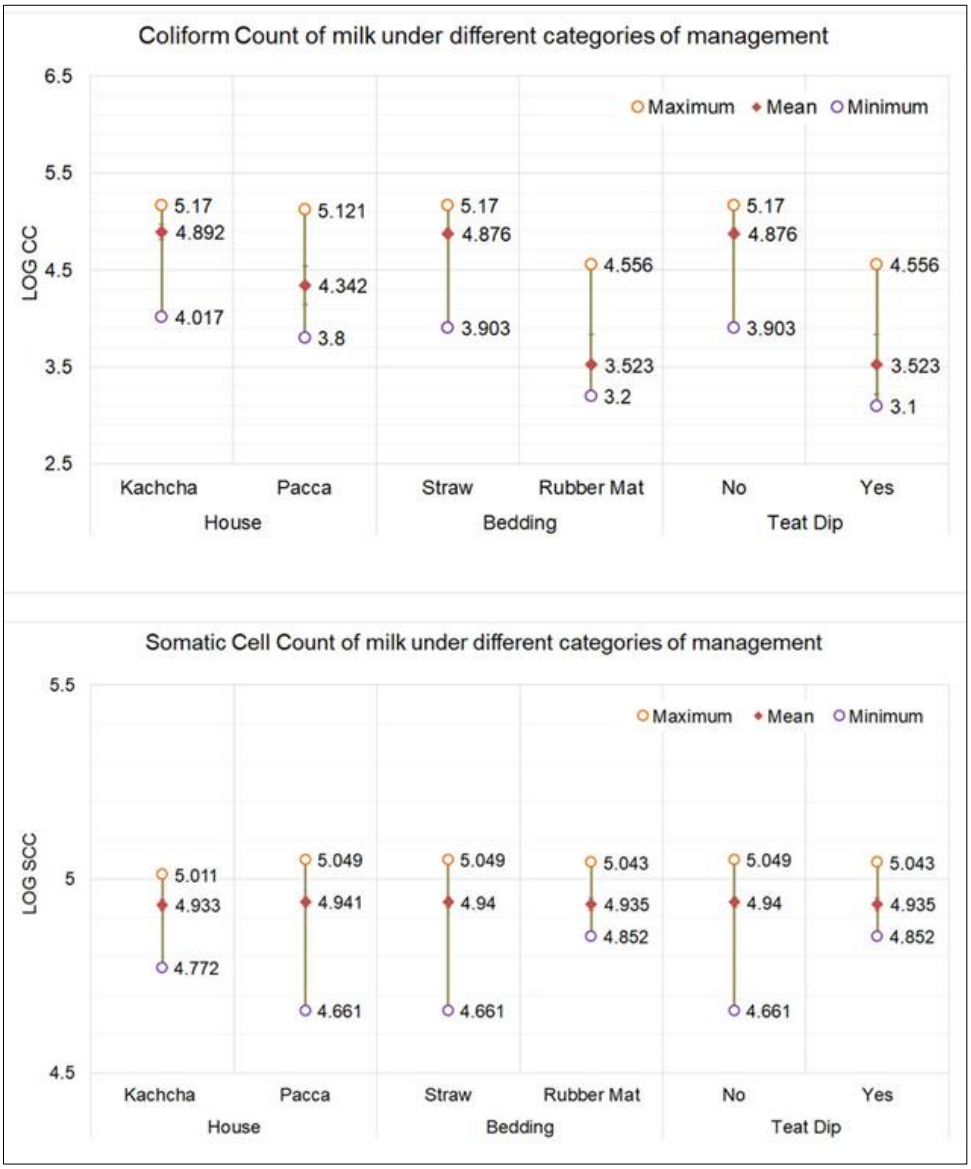


Fig 5: Mean, maximum and minimum values of SPC, CC and SCC of milk under different categories of management

Effect of different total management score on milk composition

The values of milk components fat (%), SNF (%), density and pH under different total management scores had no significant effect on the milk composition of the animals (table 8).

The mean fat percentage decreased with an increase in the total management score, but at a total management score of 9 which was the highest score, the mean milk fat percentage raised again (figure 6). The SNF. Density and pH of milk showed no definite trend with the change in TMS.

Association of different total managemental scores with microbiological quality and SCC of milk

The values of SPC, CC and SCC of milk under different total managemental conditions have been presented in table 8 and figure 7. Total management score had a significant effect on the microbiological quality of milk influencing CC. The mean log SPC was less at a higher total management score of 9 compared to a total management score 4. Similarly, mean log CC was less at a higher total management score. However, the total management score has no significant association with the log SCC of milk. Variation in microbial quality with total management score had no definite pattern.

Table 8: Effect of different total management scores on milk parameters (Mean ± SE) of animals

Parameter	TMS4		TMS5		TMS6		TMS8		TMS9	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
LOGSPC	5.939	0.055	5.824	0.069	5.687	0.189	5.736	0.057	5.661	0.088
LOGCC	4.926	0.082	4.931	0.033	4.744	0.151	4.328	0.067	3.806	0.163
LOGSCC	4.920	0.018	4.971	0.013	4.901	0.041	4.908	0.019	4.961	0.021
FAT	4.154	0.108	4.150	0.064	4.250	0.109	3.940	0.249	4.829	0.441
SNF	8.269	0.074	8.350	0.051	8.363	0.057	8.414	0.091	8.129	0.111
DENSITY	1.028	0.001	1.029	0.001	1.030	0.001	1.028	0.001	1.028	0.001
pH	6.692	0.031	6.736	0.034	6.700	0.057	6.757	0.043	6.686	0.059

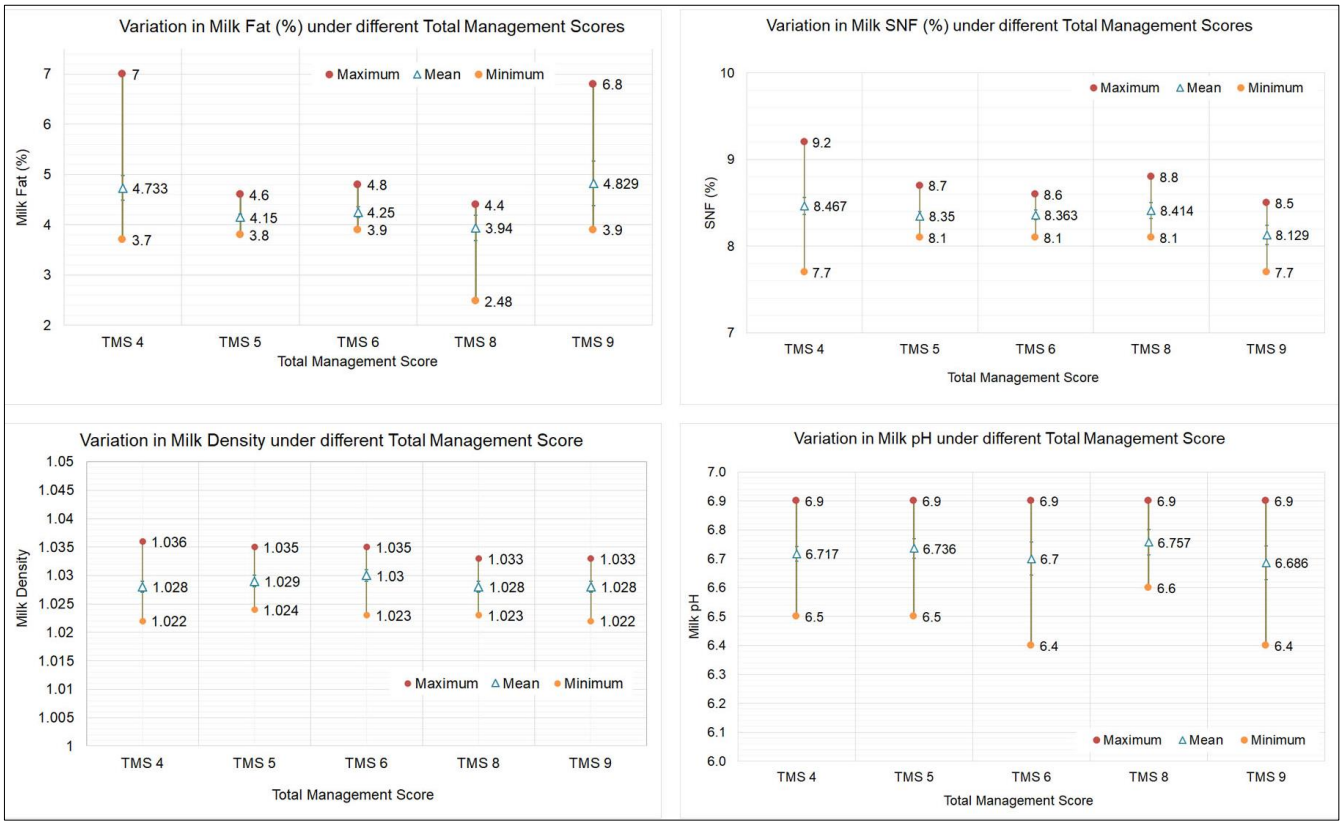


Fig 6: Mean, maximum and minimum values of different milk components under different total management Scores (Fat percent, SNF percent, Density and pH)

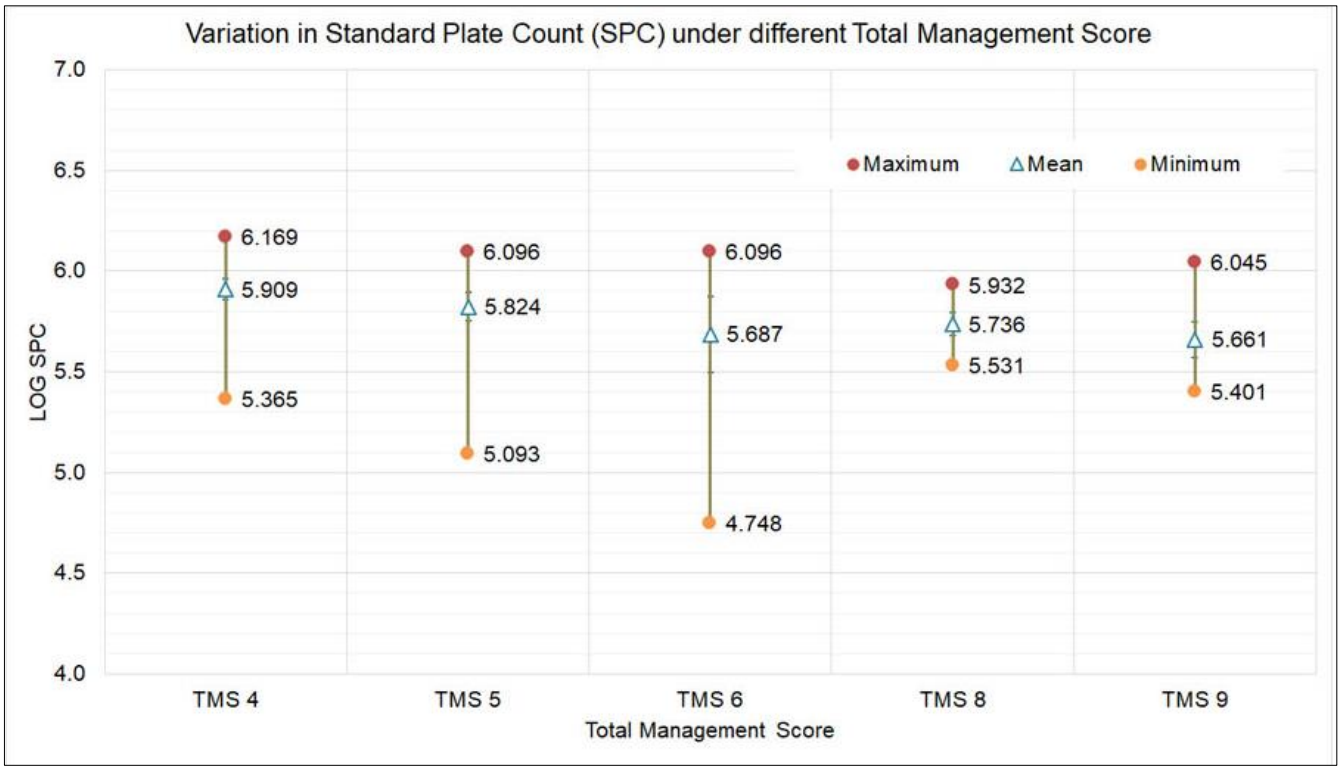


Fig 7: Mean, maximum and minimum values of SPC, CC and SCC of milk under different management score

Conclusion

Proper management of animals is imperative for udder health and quality milk production. These managemental practices should be the foundation of dairy udder health recommendations. Udder hygiene score could significantly influence the microbiological quality of milk. Although in this study different managemental parameters had no significant effect on milk composition but had a significant effect on the microbiological quality of milk. Total management score also had a significant effect on the microbiological quality of milk.

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