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Effect of milking system on production performance and milking behavioral traits in HF crossbred cattle

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Abstract
The main objective of the study was investigation of effect milking system on the on Milk yield, milk Compositions, Milking behavioral traits and somatic cell count. The present investigation was conducted on Bhestan farm (NGO), Surat with 12 HF Crossbred cows which were divided into two groups i.e., Hand milking vs. machine milking cows of six animals. Research was conducted on. Persual data revealed that milk fat% was significantly ($p<0.05$) higher in hand milked was ($2.94 \pm 0.12\%$) as compared to machine milked cows ($2.56 \pm 0.06\%$). Milk let down time was significantly ($p<0.05$) higher in hand milked was (41.25 ± 0.60 sec.) as compared to machine milked cows (33.25 ± 1.63 sec.).Total milking time was significantly ($p<0.05$) higher in hand milked was (5.51 ± 0.07 min.) as compared to machine milked cows (1.55 ± 0.05 min.). Milk flow rate was significantly ($p<0.05$) higher in machine milked was (1.23 ± 0.02 kg./min) as compared to hand milked cows (0.74 ± 0.02 kg./min).The mean value of SCC was higher in hand milked was (1.72 ± 0.11 lakhs/ml) as compared to machine milked cows (1.55 ± 0.05 lakhs/ml).finding of result suggest bellow milking behavior features and udder health with machine as compared to hand milking.

Keywords: HF crossbred cows, hand milking, machine milking, milking behavioral traits, and somatic cell count

1. Introduction
Animal husbandry is the second largest economical activity next to agriculture in India under rural condition. As per the 20[h] Livestock census (2019), cattle population in India is 193.46 million which is the world's largest population. While in Gujarat the total livestock population is 26.9millions and population of crossbred cows in number is 1.92 millions.

Holstein Friesian crossbred cows are one of the high yielding (average 6150 litters milk yield per lactation, Nath *et al*., 2016) [3] cattle which constitutes 38.91% of total crossbred cattle in India. Milking system commonly adopted by farmers are hand and machine milking cattle. Milking by hand is the oldest technique used by people to collect milk from lactating animals for human consumption is common practice followed with hand milking system. Restricted suckling, where the calf is used for initiating milk ejection and is allowed to suckle after milking (Tesorero *et al.,* 2001; Froberg *et al.,* 2007) [6, 2].

Machine milking can induce both physical and psychological stimuli with physiological adjustment including adrenocortical and haemato chemical changes particularly in dairy farms. With the change from conventional milking to automatic milking there are some factors which can affect milk quality including management, milking routine and mastitis detection (Van der Vorst *et al*. 2003) [7]. Cattle breeders are not only interested in getting more milk, but also in having a better milk quality, machine milking improves milk quality and milk components especially fat and protein percentage and lower the Somatic Cell Count (SCC) in the milk (Petrovska and Jonkus, 2014) [4]. Somatic cell count is commonly used as an indicator of udder health and subclinical mastitis in herds or individuals. When udders are healthy the SCC in milk is between 50,000 to 100,00cells/ml. (Skrzypek *et al*., 2004) [5]

2. Materials and Methods
The present investigation was conducted on 12 crossbred cows from 2nd to 5th lactation in two groups of animals. Animals were selected on the basis of previous lactation milk record with classification under treatment group on record of 1st day of milk of animal. All animals were raised under similar managemental practices in semi-loose, tail to tail pattern in pakka shed. Experiment was conducted on 12 HF crossbred cows divided into two groups on the basis of milking practices i.e., hand milking and machine.

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The hand milking was performed by full hand method. Milk yield of individual HF crossbred cows was recorded twice daily in the morning and evening for 3 months using electronic weighing balance for hand milked cows and inbuilt scale in machine milking system.

Composite milk sample from all four quarters of each HF crossbred cow was collected aseptically into a 40 ml-plastic milk sample container. Immediately after milk collection, the sample was used for milk analysis i.e., Fat (%) with the help of Fatometer Milk Analyser at fortnight interval until the end of experiment. Milk Somatic Cell Count (SCC) was calculated using Newman's-Lempert staining method as per the standard protocol (Schalm *et al.,* 1971). Clean glass slide was used for smear preparation. Milk was mixed thoroughly and 10 µl of milk sample was uniformly spread over 1sq. cm marked area on a glass slide. The milk film was left at room temperature until drying. Slides of the fixed, dried films, were submerge singly or in multiples, into the Newman-Lampert stain for 2 minutes. The excess stain was drained by resting the edge of the slide on absorbent paper. The slides were dried thoroughly. The dried stained slides were rinsed thrice in water and then drained and air dried before examining the film under the microscope. The film on the slide was examined under oil-immersion after placing one drop of immersion oil on the film.

Somatic cells were counted through 100X magnification using oil immersion lens of the microscope and were calculated as 0.01 ml (10µl) of milk was spread in 1 sq.cm. possible number of such fields which could be counted in 1 sq. cm was 3181.82. Milk volume represented by each field was = 0.01 x 1/3181.82. Hence microscopic field (MF) was 318182. Total number of such fields counted was 50.Therefore, Working Factor (WF) = 318182/50 = 6363.64.The total number of SCC/ml of milk = 6363.64 x Number of cells counted (in 50 fields).

Milking behaviour was observed at fortnight interval during the period of three months of research work. Such as letdown time, total milking time and milk flow rate. The letdown time in case of hand milking was taken as the time gap between putting the hand on udder for milking and the appearance of milk streams with considerable pace. In case of machine milking the time gap between fixing of teat cups and the appearance of milk in the collectors was recorded using stop watch.

Similarly total milking time was recorded from the moment the milker placed his hands on the udder to begin milking to the release of last drop of milk recorded from the udder. In machine milking, milking time was recorded from the moment the milking machine was fixed to the udder to release of the last streams of milk(kg/min) from the udder. Milk flow rate was watched out by dividing total milk yield with total milking time.The data on milk yield, milk fat, Somatic Cell Count, milk let down time, total milking time and milk flow rate were subjected to statistical analysis. Descriptive statistics specifying Mean±S.E was calculated for each group. One way ANOVA procedure was undertaken to compare means. Independent sample t-test was used for two group comparisons. Post Hoc multiple comparisons were made using Duncan New Multiple Range Test (DNMRT).

3. Results and Discussion
3.1 Milk yield
The effect of milking system on milk yield in HF Crossbred cows during experiment at fortnight interval under study is presented in Table 1. Overall milk yield significantly ($p<0.01$) higher in machine milked cows (8.81 ± 0.08 Kg.) as compared to hand milked cows (7.65 ± 0.05 Kg.).The milk yield of HF crossbred cows differ significantly ($p<0.05$) on 4th and 5thfortnight between group. The mean of milk yield was highly significant ($p<0.01$) on 3rd and 6th fortnight between group-1 and group-2. Milk yield showed decreasing trend in from 2nd week onward in group-1 and fluctuating trend was observed in group. While comparing within the group-1 milk yield varied significantly between 3rd fortnight vs. 1st & 2nd fortnight and in group-2 milk yield varied significantly ($p<0.01$) between 3rd fortnight vs. 2nd fortnight and 3rd fortnight vs. 4,5,6 fortnight.

Similar finding of significantly higher milk production in machine milked cow was also reported by Pandey *et al.* (1990) and Boonbrahm (2004) and Filipovic and Kokaj (2009) in Holstein crossbred cows. Lakhani and Jogi (1996) in murrah buffaloes. Sinapis (2007) reported that ewes milked by machine gave a greater daily milk yield as compared to those milked by hand (698 ml vs.652 ml; $P<0.05$). Patel *et al.* (2016), reported in their study that milk yield in Murrah buffaloes and Sahiwal cows under machine milking(5.43 ± 0.20 kg vs. 4.04 ± 0.25 kg) was higher than under hand milking (5.22 ± 0.22 kg vs.3.93 ± 0.14 kg) respectively. The higher milk yield in machine milked cow might be due to better stimulation as well as efficient and complete removal of milk in machine milking compared to hand milking system.

Table 1: Effect of hand v/s machine milking system on daily milk yield in HF crossbred cows

Fortnight	N	Hand milking (Group -1)	Machine milking (Group -2)	t value
1	90	$8.29^{c} \pm 0.09$	$8.31^{abc} \pm 0.11$	-0.91
2	90	$8.58^{c} \pm 0.07$	$8.70^{b} \pm 0.13$	-0.83
3	90	$7.57^{b} \pm 0.11$	$8.42^{c} \pm 0.21$	-3.49**
4	90	$7.23^{a} \pm 0.12$	$7.81^{a} \pm 0.23$	-2.19*
5	90	$7.10^{a} \pm 0.15$	$7.87^{ab} \pm 0.21$	-2.95**
6	90	$7.13^{a} \pm 0.15$	$7.94^{ab} \pm 0.19$	-3.38**
Overall	540	7.65 ± 0.05	8.18 ± 0.08	-5.55**
F value		27.83**	3.63**	

* & ** indicates significance at $P<0.05$ and $P<0.01$, respectively across rows and Means bearing different superscript within column differ significantly ($P<0.05$)

3.2 Milk fat%
Overall fat% significantly higher in hand milked cows (2.94 ± 0.12) as compared to machine milked cows (2.56 ± 0.06) (Table no.2). On different test day fat% was higher in hand milked cows as compared to machine milked cows though it was not significantly different. The maximum mean of fat% obtained on 6th fortnight and in group – 1 and 4th fortnight group – 2. The minimum mean of fat% obtained on 4th fortnight in group – 1 and 5th fortnight in group – 2.While comparing within the group the fat% of HF crossbred cows no significant difference ($p>0.05$) was observed. In similar findings, Boonbrahm (2004) reported hand-milked cows yielded a significantly ($P<0.001$) higher milk fat percentage (3.67%) than their machine-milked herd mates (3.55%). In contrary, Filipovic and Kokaj (2009) reported no significance difference in milk composition (fat, protein and lactose contents) between different milking systems

Table 2: Effect of hand v/s machine milking on Fat % in HF crossbred cows

Fortnight	N	Hand milking (Group -1)	Machine milking (Group -2)	t value
1	6	2.97 ± 0.31	2.56 ± 0.18	-1.106
2	6	2.93 ± 0.36	2.62 ± 0.16	-0.814
3	6	2.96 ± 0.33	2.43 ± 0.13	-1.489
4	6	2.85 ± 0.35	2.70 ± 0.19	-0.387
5	6	2.90 ± 0.31	2.53 ± 0.14	-1.062
6	6	3.03 ± 0.23	2.53 ± 0.13	-1.896
Overall	36	2.94 ± 0.12	2.56 ± 0.06	-2.793**
F value		0.039	0.325	

* & ** indicates significance at $P<0.05$ and $P<0.01$, respectively across rows and Means bearing different superscript within column differ significantly ($P<0.05$)

3.3 Somatic Cell Count (SCC) (lakhs/ml)

Overall SCC was significantly higher in hand milked (1.72 ± 0.11) as compared to machine milked cows (1.55 ± 0.05) through it was not significantly different (Table no.3). moreover, in all test days also SCC was higher in hand milked as compared to machine milked cows through the difference was not significant. The maximum mean of SCC obtained on 3rd and 4th fortnight in group – 1 and group – 2 respectively. The minimum mean of SCC obtained on 2nd fortnight in group – 1 and group – 2.While comparing within the group the SCC of HF crossbred cows no significant difference ($p>0.05$) was observed. In contrary, Boonbrahm *et al.* (2004) reported that the machine milked cows showed a significantly ($p<0.001$) higher somatic cell score than the hand milked cows throughout the study period.

Similar to our result of significantly higher milk SCC in hand milked cow has been reported by Dang and Anand (2007), Sinapis (2007). In similar findings, Filipovic and Kokaj (2009) reported that average value of SCC was much higher (65%) in milk from hand milked than machine milked cows, but difference was not significant due to the great variance of the values. Average value of microorganisms was significantly higher ($P<0.05$) in milk from hand milked cows. Due to increase SCC in hand milk cows, use of machine milking instead of hand milking can improved the hygienic quality of milk.

Table 3: Effect of hand v/s machine milking on Somatic Cell Count (SCC) in HF crossbred cows

Fortnight	N	Hand milking (Group -1)	Machine milking (Group -2)	t value
1	90	1.29 ± 0.04	1.51 ± 0.12	-1.622
2	90	1.33 ± 0.05	1.46 ± 0.12	-0.492
3	90	2.09 ± 0.32	1.57 ± 0.14	-1.496
4	90	2.05 ± 0.29	1.62 ± 0.18	-1.229
5	90	1.86 ± 0.35	1.62 ± 0.16	-0.630
6	90	1.70 ± 0.25	1.49 ± 0.08	-0.784
Overall	540	1.72 ± 0.11	1.55 ± 0.05	-1.454
F value		1.889	0.240	

* & ** indicates significance at $P<0.05$ and $P<0.01$, respectively across rows and Means bearing different superscript within column differ significantly ($P<0.05$)

3.4 Milk let down time (sec)

Overall Milk let down time was significantly higher in hand milked (41.25 ± 0.60) as compared to machine milked cows (33.25 ± 1.63).The mean let down time of HF crossbred cows was significantly ($p<0.05$) higher in hand milked cows as compared to machine milked cows on different fortnight observation. The maximum mean let down time obtained on 5th and 6th fortnight in group – 1,1^{st} and 5th fortnight in group – 2 respectively. The minimum mean let down time noticed on 2nd in group – 1 and $2^{nd},3^{rd}$, 4th and 6th fortnight in group – 2.While comparing within the group the let down time had no significant difference ($p>0.05$) in group - 2 but significant difference ($p<0.05$) was seen in the group - 1.

Similar let down was seen on 1st, 2nd, 3rd, 4th, 5th and 6th fortnight; and milk let down was significantly lower on 1st and 2nd fortnight in group-1. For harvesting clean and optimum milk, in ideal time preparing the animals is an important task for dairymen with minimum disturbance to animals.

Similar finding of significantly higher milk let down time in hand milked compared to machine milked cows reported by Singh and Dave (1985), Lallawmkimi and singh (2009) in Murrah buffaloes and also in murrah buffaloes and shahiwal cows by Patel *et al.* (2016). The possible reason might be familiarization ability of machine milked animals to the parlour environment as compared to hand milked animals.

Table 4: Effect of hand v/s machine milking on Milk let down time (sec) in HF crossbred cows

Fortnight	N	Hand milking (Group -1)	Machine milking (Group -2)	t value
1	90	$39.17^{a} \pm 1.17$	36.83 ± 3.15	-0.631
2	90	$38.33^{a} \pm 1.61$	31.00 ± 4.86	-1.433
3	90	$41.38^{ab} \pm 0.80$	30.67 ± 4.99	-2.110
4	90	$41.00^{ab} \pm 1.55$	32.17 ± 4.29	-1.936
5	90	$44.17^{b} \pm 1.05$	38.33 ± 1.71	-2.915*
6	90	$43.50^{b} \pm 1.31$	30.50 ± 4.28	-2.904*
Overall	540	41.25 ± 0.60	33.25 ± 1.63	-4.594**
F value		3.245*	0.707	

* & ** indicates significance at $P<0.05$ and $P<0.01$, respectively across rows and columns. Means bearing different superscript within column differ significantly ($P<0.05$)

3.5. Total milking time (min)

Overall Total milking time significantly higher in hand milked cows (5.51 ± 0.07) as compared to machine milked cows (1.55 ± 0.05). The mean of total milking time of HF crossbred cows was significantly ($p<0.01$) higher in hand milked cows as compared to machine milked cows on different fortnight observation. The maximum mean total milking time obtained on 2nd and 3rd fortnight in group – 1 and group – 2 respectively. The minimum mean total milking time noticed on 6th in group – 1 and 4th and 5th fortnight in group – 2. While comparing within the group the milking time of HF crossbred cows significant. Total milking time in hand milked cows was non-significant at different fortnight observations. Complete milking time is the time required from the start of actual milking by full grasp method either by hands or by machine till the complete removal of milk from udder including the time required for stripping. Similar

finding of significantly higher milking time in hand milked cow has been reported by Filipovic and Kokaj (2009) milking time was significantly shorter (4.42 vs. 6.05 min, $P<0.05$) at machine than hand milking and Patel *et al.* (2016) reported that average total milking time in Murrah buffaloes under machine milking was significantly ($P<0.05$) less than that of hand milking (487.49 ± 18.72 Vs. 520.78 ± 18.94 second), where as in Sahiwal cows it was less (363.05 ± 14.05 Vs. and 369.37 ± 12.00) but the difference was not significant. The present observations were in contrary to the findings reported by Dogra *et al.* (2002) who measured the effects of machine milking in lactating Murrah buffaloes on temperament and milk production and reported that machine milking time was 4.32 ± 0.03 and 2.66 ± 0.17 min. respectively for docile and nervous animals and docile animals had the highest machine milk yield.

Table 5: Effect of hand v/s machine milking on Total milking time (min) in HF crossbred cows

Fortnight	N	Hand milking (Group -1)	Machine milking (Group -2)	t value
1	90	5.68 ± 0.15	3.51 ± 0.08	-12.447**
2	90	5.75± 0.16	3.78± 0.11	-9.990**
3	90	5.55 ± 0.17	3.62 ± 0.15	-8.444**
4	90	5.43 ± 0.17	3.31 ± 0.16	-9.052**
5	90	5.34 ± 0.18	3.32 ± 0.14	-8.958**
6	90	5.29 ± 0.18	3.47 ± 0.12	-8.466**
Overall	540	5.51 ± 0.07	1.55 ± 0.05	-22.956**
F value		0.315	1.975	

* & ** indicates significance at *P<0.05* and *P<0.01*, respectively across rows and columns.
Means bearing different superscript within column differ significantly (*P<0.05*)

3.6. Milk flow rate (kg/min)

Overall milk flow rate significantly higher in machine milked cows (2.47 ± 0.02) as compared to hand milked cows (1.49 ± 0.02)(Table no.6).The mean milk flow rate of HF crossbred cows was significantly ($p<0.01$) higher in machine milked cows as compared to hand milked cows on different fortnight observation. The maximum mean milk flow rate obtained on 2nd fortnight in group – 1 and 4th fortnight in group – 2 respectively. The minimum mean milk flow rate noticed on 4th and 5th in group – 1, 2nd and 6th fortnight in group – 2. While comparing within the group the milking time of HF crossbred cows was significant ($p<0.01$) difference (F=-

2.769). Milk flow rate in hand milked cows were significant at different fortnight observations. Milk flow rate in hand milked cows were highest on 2nd fortnight. Similar milk flow rate was seen on $1^{st}, 3^{rd}$ and 6th fortnight and milk let down was significantly lower on 4th and 5th fortnight.

Similar finding were reported in sahiwal and tharparkar cows by Sunderesan *et al.* (1964), Pandey *et al.* (1990) and in murrah buffaloes and sahiwal cows by Patel *et al.* (2016). The reason might be slower milk ejection and lower degree of udder filling in hand milked animals compared to machine milked animals.

Table 6: Effect of hand v/s machine milking on Milk flow rate (kg/min)in HF crossbred cows

Fortnight	N	Hand milking (Group -1)	Machine milking (Group -2)	t value
1	6	1.55 ± 0.04	2.44 ± 0.04	-15.624**
2	6	1.59 ± 0.04	2.40 ± 0.04	-13.041**
3	6	1.47± 0.04	2.47 ± 0.05	-14.957**
4	6	1.43 ± 0.03	2.59 ± 0.07	-14.180**
5	6	1.43 ± 0.04	2.53 ± 0.06	-14.533**
6	6	1.44 ± 0.03	2.38 ± 0.05	-14.753**
Overall	36	1.49 ± 0.02	2.47 ± 0.02	-35.014**
F value		2.769**	2.077	

* & ** indicates significance at *P<0.05* and *P<0.01*, respectively across rows and columns.
Means bearing different superscript within column differ significantly (*P<0.05*)

4. Conclusions

The result of study indicate that milking methods has significant effect over milk yield, milk compositions and milking behavioural traits. milk yield was significantly ($p<0.01$) higher in machine milked as compared to hand milked cow ,whereas milk fat% (2.94 vs. 2.56%) was significantly ($p<0.05$) higher in hand milked as compared to

machine milked HF crossbred cows. Milking behavioural traits such as letdown time and milking time was significantly ($p<0.001$) higher in hand milked as compared to machine milked cow; however, milk flow rate was significantly ($p<0.001$) higher in machine milked as compared to hand milked HF crossbred cows. Thus machine milking favors' expression of better milking behavior along with high milk

yield and milk quality.

5. Acknowledgments

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