COMPARATIVE STUDIES ON MILKING TEMPERAMENT AND SOMATIC CELL COUNT OF SAHIWAL COWS AND MURRAH BUFFALOES UNDER HAND AND MACHINE MILKING ENVIRONMENTS

THESIS
SUBMITTED TO THE
NATIONAL DAIRY RESEARCH INSTITUTE, KARNAL
(DEEMED UNIVERSITY)
IN PARTIAL FULFILMENT OF THE REQUIREMENT
FOR THE DEGREE OF

MASTER OF SCIENCE
IN DAIRYING
(LIVESTOCK PRODUCTION & MANAGEMENT)

BY

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KARNAL-132001 (HARYANA), INDIA
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This is to certify that the thesis entitled **"COMPARATIVE STUDIES ON MILKING TEMPERAMENT AND SOMATIC CELL COUNT OF SAHIWAL COWS AND MURRAH BUFFALOES UNDER HAND AND MACHINE MILKING SYSTEMS"** by **Dr.Pramod Kumar Pathak** in partial fulfilment of the requirements for the Award of the Degree of **MASTER OF SCIENCE (DAIRYING)** in **LIVESTOCK PRODUCTION AND MANAGEMENT** of the **National Dairy Research Institute (Deemed University)**, Karnal (Haryana), India, is a bonafide research work carried out by him under my supervision and guidance and no part of the thesis has been submitted for any other degree or diploma.

Date : June 10,2002

(SHIV PRASAD)
GUIDE & CHAIRMAN

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Pramod Kumar Pathak

Date : June 10, 2002 **(PRAMOD KUMAR PATHAK)**

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LIST OF ABBREVIATIONS

S.No.	Abbreviations	Stands for
1.	S.N.	Serial Number
2.	Cm	Centimeter
3.	Kg	Kilogram
4.	Sec	Second
5.	Scc	Somatic cell count
6.	gm	Gram
7.	ml	Milli litre
8.	B.I.S	Bureau of Indian Standards
9.	T.P.	Transverse processes
10.	NDRI	National Dairy Research Institute,Karnal
11.	PMN	Polymorphic Neutrophils
12.	LF	Left front
13.	LH	Left hind
14.	RF	Rigth front Right
15.	RH	Rigth hind

ABSTRACT

The present study was aimed at addressing the issue of hand milking vis-a-vis machine milking in indigenous Sahiwal cows and Murrah buffaloes. The emphasis was laid upon the changes witnessed in milking temperament and somatic cell count (SCC) under hand and machine milking environment. Thirty Murrah buffaloes and 30 Sahiwal cows were divided in two groups each and investigated under hand and machine milking environments respectively. The animals in perfect health were selected for the study based on clinical check up and laboratory diagnosis was employed for ruling out sub-clinical mastitis. The results indicated that Murrah buffaloes were significantly more temperamental compared to Sahiwal cows. It was established that machine milking can be done in Murrah buffaloes and Sahiwal cows without appreciable adverse effect on milking behaviour or SCC. Better milking rate of cows under machine milking indicated better adaptability of Sahiwal cows for machine milking vis-a-vis Murrah buffaloes. The temperament score was found to have moderate to high association with species,body condition score, milking time, letdown time, udder characteristics & SCC. Milk yield had high negative association with body weight and moderate positive association with temperament score. Let down time varied significantly among the two species between milking systems and fortnights.

सारांश

वर्त्तमान अध्ययन घरेलू साहीवाल गाय एवं मुर्राह भैंसों में हस्त एवं मशीन दोहन के मुद्दे को सम्बोधित करने पर लक्षित था । हस्त एवं मशीन दोहन परिवेशों मे दोहन स्वभाव तथा शारीरिक कोशा गणनां में होने वाले परिवर्तनों पर जोर दिया गया । तीस मुर्राह भैंसों तथा तीस साहीवाल गायों को दो दो समूहों मे बांट कर उनकों हस्त एवं मशीन दोहन परिवेशों में अध्ययन किया गया ।

अध्ययन हेतु पूर्णत: स्वस्थ पशुओं कों चयन चिकित्सकीय परीक्षण तथा प्रयोगशाला निदान के आधार पर किया गया ताकि अवरोग-लाक्षणिक प्रभावों को निरस्त किया जा सके। परिणामों से मुर्राह भैंसों के साहीवाल गायों की अपेक्षा अधिक भावुक होने का संकेत मिला । मशीन दोहित गायों की अधि ाक दोहन दर ने साहीवाल गायों की श्रेष्ठतर समायोजन-शीलता का परिचय दिया । मुर्राह भैंसों एवं साहीवाल गायों में स्वभाव एवं शारीरिक कोशा गणना सम्बन्धी प्रशंसनीय हानि के बिना मशीन दोहन की सम्भाव्यता स्थापित की गयी । स्वभाव सूचकाङ्क, जाति, शरीर-स्थिति मूल्य, दोहन काल, दुग्धनोत्प्रेरण काल, अयन विशेषकों, एवं शारीरिक कोशा गणना से सामान्य से अधिक तक सम्बद्ध पाया गया । दूध-उपज का शरीर भार से ऋणात्मक तथा स्वभाव सूचकाङ्क से धनात्मक सहसम्बन्ध पाया गया । दोहनो-त्प्रेरण काल, दोनों जातियों, दोहन प्रणालियों तथा पक्षों के मध्य सार्थक रूप से भिन्न था ।

Introduction

1. INTRODUCTION

The quest to enhance the efficiency of milk production led the dairymen to different innovations in milk production system. Machine milking was introduced as an alternative of hand milking at organised farms for the same purpose. This change in the milking environment brought changes in the temperamental parameters and somatic cell counts of cows and buffaloes.

The future growth of dairy sector will necessitate the animals to be milked at organised farms through machine milking system. Murrah buffaloes and Sahiwal cows are considered to be the two main indigenous breeds having a sizeable contribution to the total milk production. The researcher wants to find out whether the machine milking can be safely resorted to in these animals or not? Further would it have any implication regarding quality or production of milk ? Are there any changes witnessed in the milking temperament of the animal? These were the few questions, the worker wanted to find out the answers.

Somatic cell count is considered to be the most accurate test for udder health (Nazem *et al.*, 1983; Sahoo and Meck, 1982). The penchant to know the contribution of milking environment on somatic cell count constituted one major objective of the present study.

The quick and complete milking process is based on the milking temperament of animals. The nervous type animals showed longest letdown time and lowest milk yield in Murrah buffaloes (Roy and Nagpaul, 1984; Mondal, 1999). The milk yield, letdown time, milking time and milk flow rate were significantly influenced by the temperament of the buffaloes (Mallick *et al.*, 1993). Hence, the worker was interested in studying these temperamental parameters under machine and hand milking environments.

The body condition of an animal reflects it's capacity to produce the milk. A comparative analysis of body condition is of vital importance in optimizing the production process of milk under prevalent conditions. It is further relevant to identify the individual animals requiring special management and care to utilize their production potential.

To assess the body condition of the animal objectively several workers have used "Body condition scoring technique (Lowman *et al.*, 1973; Earle, 1976; Mulvany, 1977; MacMillan,1982; Wildman et al., 1982; Nicholson and Butterøwrths, 1985; Gerloff, 1987).

These condition scoring systems are based on mainly observation and / or palpation of body parts such as vertebral column, transverse processes, tail head region and ribs of the animal and assigning numerical values to each point based on the amount of fat deposited over these points and dliffer only on account of the weightage given to the respective points and scale used.There is very limited number of farms where Sahiwal cows or Murrah buffaloes have been put under machine milking.There are virtually no studies to establish there suitability for machine milking.

In the backdrop of the above information and in view of the fact that comparisons of this nature have not been switched upon, the present investigation was planned to probe into this problem. The major objectives were as follows:-

1) To study the milking temperament of Sahiwal cows and buffaloes under hand and machine milking environments.

2) To compare the somatic cell count of Sahiwal cows and Murrah buffaloes under hand and machine milking environments.

3) To make recommendations on milking management of Sahiwal cows and Murrah buffaloes.

Review of Literature

2. REVIEW OF LITERATURE

The literature was reviewed in different heads as follows:

2.1 MILKING TEMPERAMENT

Behaviour of dairy animals is usually studied from their activity in milking parlour, farm yard and calving pen. Cows and buffaloes vary widely in their behaviour patterns (Dash, 1974). He reported an increase in milking time by 24.41 seconds with every 1 point increase in temperament score . The studies on the behaviour of dairy animals at the time of milking in terms of temperament and activity may facilitate the managemental care in dairy farms (Roy and Nagpaul, 1984).

Tulloh (1961) observed the temperament of Hereford, Angus and Short horn, on the basis of a six point score system (Docile-1, slightly restless-3, Nervous-4, Wild-5 and Aggressive-6) and found that Hereford and Angus had better temperament than shorthorns. Differences between sexes were not significant. On comparing temperament with live weight better growing tendency was observed in docile animals than in those which were restless, nervous, wild, or aggressive. Scott (1956) reported that in females lactation is initiated and controlled by neuroendocrine system. The cows have inherent characteristic of secreting milk and ejecting it in response to suckling stimulus.

Kudryavtzeb (1962) established relationship between temperament and milking potential. Sanguine animals had highest milking potential. Phlegmatic cows showed good milking potential. The milk yield was seldom high in choleric cows. Milking potential of melancholic cows was low.

Dickson (1966) studied the milking behaviour of cows, ranked them according to temperament during milking from 1(docile) to 5 (very nervous) and established correlation between age and temperament, stage of lactation and temperament and daily yield and temperament to be -0.12,-0.04 and -0.05 respectively.

Dickson *et al.* (1970) studied the social dominance and milking temperment of 1017 cows in 28 Wisconsin Holstein Herds. They ranked the cows docile, restless, nervous and wild,and aggressive by alloting temperament scores. They found the mean temperament score to be 1.9, heritability of unadjusted and adjusted temperament score to be 0.52 and 0.47 respectively. The correlation of daily milk yield and temperament rating was -0.05.

Foley *et al.* (1972) said that in dairy animals, complex reaction and interaction of nervous and endocrine systems, past experience, and previous training determine the behaviour which shows how do they react to other animals, to farm people and to stress.

Baryshnikov and Kokorina (1966) observed that the type of nervous activity / system in cattle was of great importance for establishing the best system for rearing and keeping farm animals so as to obtain high yielding cows suitable for machine milking.

Pavlovian concept gave components of the temperament and tried to separate them. Accordingly, animals could be divided into two main nervous processes - Excitement and tranquility. The existence of these processes in great force made a strong type animal, otherwise, it would be of weak type. Further, if the excitement force and tranquility force were equal, the animal was of the balanced type and the very unequal nature gave an unbalanced nature.

Kudryavtzeb (loc.cit) established four main types of nervous activity and characterized them categorically. A direct relationship was recorded between mobility or nervous system

and daily milk yield. The relationship between milk production and the type of nervous activity made it possible to utilize the method of conditioned reflex for raising the milk production through breeding cattle of desired type. On the management of nervous cows, Scholl (1956,1970) reported that they could be made best producers provided that such cows were handled gently. When the nervous cows gained the confidence and realised that no harm would come to them, they responded accordingly, but they forgot their acquired manner on small provocation and reverted to their former behaviour.

Behaviour of animals in general is a very complex phenomenon. Klinghammer and Fox (1971) describe behaviour as a product of a series of genotype-environ ment interactions to which the 0rganism is exposed during it's development. It is influenced by external factors and is under the immediate control of nervine and endocrine system.

According to Roy and Nagpaul (1985), studies on the behaviour of dairy animals at the time of milking in terms of temperament and activity may facilitate the managemental care in dairy farms. Roy and Nagpaul (1984) also reported that Karan Swiss and Karan Fries cows were more docile than Murrah buffaloes.

Gangwar (1983) conducted a study on Murrah and Nili Ravi buffaloes over four years period. The females were categorised for temperament during milking from very docile (1) to very restless (4). The mean number with temperament score (1), i.e., very docile was higher ($P<0.01$) in winter than in hot dry or hot humid summer season and the mean number of animals in each of the other temperament categories was higher ($P<0.05$) in the hot dry summer than in other season.

Nayak and Mishra (1984) studied the temperament of Red Sindhi ,and crossbred cows and Murrah buffaloes which were scored as docile, restless, nervous and aggressive.

Differences in respect of breeds and temperament were significant ($P<0.01$) for rate of concentrate intake. Correlation between temperament and duration traits were positive and correlations with other traits were negative ($P<0.01$) indicating that a docile temperament is an economically important characteristic in dairy cattle.

Khanna and Sharma (1988) analysed temperament score during milking (docile-1, aggressive-4) in six lactations of Haryana, Sahiwal and Tharparkar cows and corss-breds with 50 or 75% exotic inheritance. The average score ranged from 1.26 in to 2.33 ($P<0.01$) in Sahiwal cows. Temperament score was not significantly affected by lactation number and score did not significantly affect milk yield.

Fordyce *et. al* (1982) used a seven digit numerical scale for Australian cattle in range.

2.2 MILK YIELD

Docile cows during milking, yield more milk and save the labour involvement. In other words, the high milk producing cows are generally docile (Tulloh, 1961).

Kudryavtzev (1962) established relationship between temperament and milking potential. Sanguine animals had highest milking potential. Phlegmatic cows showed good milking potential. The milk yield was seldom high in choleric cows. Milking potential of Melancholic cows was low. Kudryavtzeb (1962) observed higher nervous activity and physiology of senses in lactating cows. Rai (1991) in his studies on certain behavioural patterns in Murrah buffaloes under loose housing system observed that from the quantitative as well as qualitative point of view of the milk produced, a sound milking management must be adopted in both the organised farm and under village condition.Drogociw *et al.* (1976) found 25-30 percent more milk in tractable cows as compared to others. Rahman *et al.* (1988) observed milkability of Murrah buffaloes in relation to their dairy temperaments

classified as (i) docile, (ii) slightly restless, (iii) restless, (iv) nervous and (v) aggressive. They recorded mean milk let down time (min), milk flow rate (kg/min) and 150 days milk yield (kg) respectively as following (i) 1.85, 0.87, and 1454.5, (ii) 1.92, 0.81, 1400.82, (iii) 2.0, 0.86 and 1392.72, (iv) 2.15, 0.79 and 1246.77 and (v) 1.88, 0.82 and 1193.64. They reported that dairy temperament had a significant effect ($P<0.01$) on letdown time, milking time, milk flow rate, fat %, total solid % and total and 150 days yield.

2.3 MILK FLOW RATE

According to Aliev (1956 and 1969), the milking process mainly involves the application of the suckling (milking) stimulus for a proper milking ejection and rapid removal of milk during the period of oxytocic contraction of myoepithelial cells enveloping the alveoli and fine ducts in the secretory components of the mammary gland. Due to strong maternal instinct of buffaloes, the structure and physiology of udder and the secretory activity are essentially unique to the species and greatly affect the milk ejection and milk flow and thereby milking operation.

According to Nanda *et al.* (1988) and Singh (1989), quick and efficient milking of crossbred cows in terms of milk flow rate was observed by many workers. They observed varied results ranging from 624-946 gm/min. Pandey *et al.* (1990) observed a significantly higher milk flow rate in first to third stages of lactation compared with the 4th and 5th stage. Rai (1991) observed 0.946, 0.792 and 0.570 kg/min milk flow rate under village farm condition, urban dairies and in organised government dairy farm. Tripathi (1991) observed a significant difference between deshi and crossbred and lactation stages for milk flow rate in dairy cattle. Their observation revealed the milk flow rate for two breed types as 0.57±0.01 and 0.81±0.002 kg/min in mid lactations; 0.39±0.07 and 0.78±0.02 kg/min in late lactation and

concluded that the highest milk flow rate is observed in mid lactation. Their findings for breed difference were not significant. Significant effect of breed and stage of lactation on temperament was observed by Roy and Nagpaul (1984). Their observations revealed that the temperament score in Karan Swiss and Karan Fries were 1.66 and 1.60 respectively.

Bhagat *et al.* (1992) observed that the milk yield, milking time and milk flow rate were significantly influenced due to the skill of milkers particularly in medium herd and hard to milk categories of buffaloes. Singh and Tomer (1994) observed milk flow rate of 624 gm/minute in crossbred cattle and found a significant positive effect of milk yield and negative effect of age of the milker and parity on the milk flow rate.

Tishanikov *et al.* (1996) studied the milk yield, effective level of suction for the milking equipment, length of milking session, cross section of milk flow,and milk quality, depend on man-machine-animal interactions.

2.4 LETDOWN TIME

Alim *et al.* (1977) found that dry hand method of massaging the udder was comparatively better resulting in early let down, higher average daily yield and slightly more flow rate.Lohr and Troger (1977) reported that the let down time was not significantly influenced by stimulation method, age of the cow and time of milking.

2.5 SOMATIC CELL COUNT

Cuccuru *et al.* (1977) reported two different dynamics of differential cell counts: one concerning with polymorphonuclear neutrophil leukocytes and macrophages, and other concerning lymphocytes and epithelial cells. Macrophages and PMN in particular increased as lactation progressed, while lymphocytes and epithelial cells uniformly increased. The relationship between somatic cell counts and differential cell counts indicated that PMN was

the only cell type increasing when somatic cell counts increased. The progressive increase in somatic cell count during lactation in the absence of infection was probably an effect of cell concentration owing to reduction in milk yield, while the increases in PMN and macrophages were very likely consequences of immune mechanisms approaching the dry period. Sethar *et al.* (1979) in their studies reported highest SCC just after calving which decreased upto days 31 to 60 of lactation and then increased slowly to the end of lactation. Kitchen and Barry (1981) reported that somatic cell count in normal cow milk is 20-1000 x 10^3 cells/ml. Mitchell et al. (1986) reported that milk fat was negatively correlated with milk somatic cell counts. Randy et al. (1988) observed low and negative correlation coefficient between milk yield and somatic cell counts, SCC being higher in afternoon milking.

Vecht *et al.* (1989), Jorstad *et. al* (1989) and Schukken *et al.* (1992) reported that several factors like season, geographical region, type of housing, teat disinfection, management, type of feed and teat injury significantly infuence somatic cell counts in cows and buffaloes. Timms (1990) reported that cows with initial low SCC were found not to be at greater risk to further mastitis infections than the cows with initial high SCC. Silva and Silva (1994) reported that total SCC in normal buffalo milk varied from 50000 to 375000 cells/ml. Nazem *et al.* (1998) reported that somatic cell count was the most accurate test but was relatively time consuming for confirmatory method of udder health. According to Lakhani and Singh (1998), raw milk obtained by machine milking showed better keeping quality than hand milking. Prasad (2000) observed that the normal values of SCC during early lactation varied from 0.54 to 0.75 x 10^5 cells/ml.

Rupp and Boichard (2000) estimated relationship between initial somatic cell count and time to first clinical mastitis from data including 20,422 heifers and reported that without

clinical signs of mastitis during the first month of lactation with a first test day SCC lower than 400,000 cells/ml. The cows with lowest initial SCC had the lowest risk for clinical mastitis. First test day SCC was more variable and not fully representative of the rest of the lactation. The initial somatic cell count was in a range of 35000 to 400000 cells/ml.

Singh and Ludri (2001) in their studies observed that milking interval did not influence the secretion of somatic cells and on an average SCC were recorded to be around 1.0×10^5 cell/ml irrespective of time of milking, parity and stage of lactation in buffaloes. Prasad and Singh (2001) reported that the somatic cell counts ($P<0.01$) and epithelial cells ($P<0.05$) varied between buffaloes and between periods of study.

Materials and Methods

3. MATERIALS AND METHODS

3.1 LOCATION OF THE FARM

The study was conducted at the Dairy Farm, N.D.R.I. located in Karnal city of Haryana State. The geographical location is - latitude 29° 43"N and longitude 77° .2"E. The elevation of Karnal above mean sea level is 250 metre. The ambient temperature fluctuates from near freezing point in winter to 45° C in extreme summers. The annual rain fall is about 70 cm.

3.2 DETAILS OF THE EXPERIMENTAL ANIMALS

Thirty lactating Murrah buffaloes and 30 Sahiwal cows were selected for the present study. Fifteen animals of each above stated species were subjected to machine milking and hand milking. Thus there were four groups of 15 animals each. The particulars of animals were as follows:

Details of Experimental animals

Animal No.	Date of Calving
A. Buffaloes under Hand milking	
3343	13.10.01
3402	08.06.01
3543	24.12.01
3693	08.12.01
3766	04.08.01

4015	01.01.01
4142	13.10.01
4242	18.09.01
4243	23.12.01
4354	10.07.01
4441	14.07.01
4488	18.09.01
4504	23.08.01
4531	16.10.01
4554	31.12.01

B. Buffaloes under machine milking

3910	12.07.01
3957	05.07.01
4045	04.08.01
4133	05.07.01
4362	23.07.01
4402	22.10.01
4461	05.08.01
4532	29.07.01
4591	13.10.01
4646	09.12.01
4658	21.07.01
4699	24.11.01

4768	13.10.01
4737	07.08.98
4739	10.08.98

C. Cow under Hand milking

1200	30.12.01
1213	30.11.01
1231	10.07.01
1259	10.11.01
1262	02.01.02
1267	26.11.01
1281	04.09.01
1292	17.12.01
1315	03.11.01
1333	29.11.01
1347	18.09.01
1370	12.12.01
1379	26.11.01
1392	05.09.01
1544	24.11.01

D. Cows under machine milking

1103	14.07.01
1213	30.10.01
1225	30.10.01

1230	31.10.01
1273	18.01.01
1281	04.09.01
1284	02.08.01
1292	17.12.01
1293	26.05.01
1296	11.01.02
1362	12.08.01
1398	11.01.01
1413	20.11.98
1432	20.11.98
1440	17.02.99

3.3 ANIMAL MANAGEMENT AND HYGIENE

The animals were maintained in loose housing system. They were offered green fodder ad libitum in their paddock and concentrate during milking in the byre. The feeding, management and housing conditions were as per the standards being followed at the Institute.

The machine milking was carried out in clean milking byres. The animals were brought at the scheduled time in milking byre and concentrate were provided in the manger. The udder, hind quarters and perenial region were thoroughly washed with clean water and then milking procedure was followed.

For hand milking the milker approached the animal, patted her on back, washed and massaged the teats. When milk was let down, the full hand milking was practiced.

3.4 DETAILS OF MACHINE MILKING

Electrically operated floor mounted Alpha laval combine milker machines were used in present study. The pulsation rate was maintained around 50 per minute and vacuum level of 400 mm of Mercury was maintained.

After washing the animals, each was stimulated for letdown and the time was noted down. After letdown the animal was milked. The pulsators were attached to the vacuum clock and the valve was turned. The claw was held in the left hand and the teat cups were attached to the teats by right hand. The stripping was done by gently pulling down the claw. The yield of milk was noted down and the milking time was recorded. The average secretion rate was obtained by dividing the milk yield with milking time.

3.5 MILKING TEMPERAMENT

The animals were carefully observed and their activities were ~~jotted~~ noted down in the milking byre. Ranks were awarded on a five point score card as following (Tulloh, 1961) modified by Mishra *et al.* (1975) and modified by the worker himself.

Description of different levels of milking temperament of animals

Temperament	Description	Score
Docile	The animal stands quietly, rarely moves except to raise or lower head;never gives any trouble, extremely docile during milking and preparation, generally not affected by the whole procedure "ideal milker"	1

Slightly Restless	The animal stands quietly in the stall; not bothered by preparation or milking; but may move frequently shifting weight from side to side; may flick tail occasionally; gives very less trouble.	2
Moderately Restless	The animal moves almost continuously, flicks tails frequently, snoils, may lift fast occasionally during preparation; but does not kick, may be stubborn.	3
Highly Restless	The animal moves continuously, growls, occasionally intimidates the milker	4
Slightly Nervous	The animal appears very restless during preparation or milking but does not kick, quivers when hand is placed on back, flicks tail frequently.	5
Highly Nervous	The animal is restless without a break, always intimidates the milker during preparation or milking; struggles violently, kicks at milker, attacks observer by butting occasionally.	6
Wild	The animal is very restless during preparation or milking; struggles violently, kicks at milker, attacks observer by butting; moves from side to side; very difficult to handle.	7

3.6. PARAMETERS RECORDED

3.6.1 Milk Letdown Time

The time taken from application of milking stimuli till the engorgement of udder and teats was recorded with the help of a stop watch.

3.6.2 Milking Time

It is the time required for the accomplishment of the milking process including the time spent on strippings and was recorded with the help of a stop watch.

3.6.3 Milk yield

The amount of milk obtained after complete milking was weighed on a spring balance and recorded as kilograms.

3.6.4 Milking Rate

Milking rate was calculated by dividing milk produced (gm) by the time spent on milking including strippings (secs).

3.6.5 Parity

The animals were accorded 1,2,and 3 codes for first, 2 for 2-3 and 3 for fourth or more parity.

3.6.6 Stage of lactation

First three months of stage of lactation were recorded as 1, three to six months as 2, and six months or beyond as 3.

3.6.7 Modified California Mastitis Test(MCMT)

Prior to S.C.C. the animals were subjected to Modified California Mastitis Test to rule out clinical/sub-clinical mastitis.

The CMT developed by Schalm and Moorlander in 1957 was modified according to Shastry (1978) for the present study. The reagent used consists of an anionic surface active reagent and the indicator dye. The composition of the reagent was as follows:

Sodium hydroxide	1.5 gm
Teepol	0.5 ml

Bromothymol blue	0.01 gm
Distilled water	upto 100 ml

As the reagent used by Schalm (Triethanolamine sulphonate) is not readily available in India, so the modified method has the same efficacy.

Procedure

This test requires a white plastic milk paddle with four shallow cups. For convenience, the cups were marked as LF, LH, RF and RH for left fore, left hind, right fore and right hind, respectively. The testing reagent was dispensed in a plastic bottle provided with a fine nozzle. On squeezing the bottle a zet of the reagent could be added into the cups. The test was performed in the following way.

After preparing the udder and discarding the fore milk (3-4 streaks) one strip of milk about 3 ml was drawn directly from the teats into cups. Then equal quantity of reagent was added and mixed properly by gentle circular movement (clockwise and anticlockwise) of the paddle for about 10 seconds. Reaction occurred immediately and there was precipitation and gel formation in positive cases. Positive milk samples turned greenish blue due to alkalinity. Due to the presence of increased number of leucocytes, a precipitate or gel was formed. Depending upon the degree of gel formation the grades were assigned as following:-

0 - The appearance of the test reagent and solution remained unchanged with the mixture remaining liquid.

1 - There was a precipitate but no gel formation.

2 - The precipitate got thickened and concentrated towards the center of the plastic cup during movement of paddle.

3 - Distinct gelling which adhered to the bottom of the paddle.

In this study, 0 was regarded as negative or healthy and score 1, 2 and 3 was considered as positive indication of udder infection, where score 1 means mild infection, 2 means moderate infection and 3 means severe infection.

3.6.8 Somatic Cell Count (SCC)

The total number of somatic cells (mainly neutrophils but also other leukocytes) secreted per ml of milk were estimated using Prescott and Breed (1910) method which has been approved later on by B.I.S. (1981).

Procedure

The sample was shaken thoroughly to disperse the cream throughout the specimen. A measured drop of 0.01 ml milk was then withdrawn with the help of a pipette. This drop was then spread evenly over an area of 1 sq.cm. on an ordinary glass slide. 1 by 3 inch microslide was employed and a card was prepared that outlined 1 sq.cm. over which the milk was spread.

While spreading the milk, care was taken to ensure even distribution of the sample over the entire area. The milk was then air dried just keeping the slide on a flat surface.

After the films got dried, the slides were submerged in clear xylene for few minutes to dissolve out the fat. The slide was then taken out, dried and the smear was fixed to the slide by immersion in 90-95% ethyl alcohol for one minute or by gently pouring the alcohol over the film.

The slides were allowed to drain and were air dried completely. Then the slides were dipped edgewise in alcoholic methylene blue staining solution for one or two minutes.

[Alcoholic Methylene blue staining solution was prepared by adding 0.6 gm methylene

blue chloride to 100 ml of 95 percent ethyl alcohol, shaken for some time, left at room temperature for 24 to 48 hours shaking at intervals until the dye got completely dissolved and then stored in clear, tightly closed container.]

The slides were slowly removed, allowing a few seconds for stain and to drain the stain into staining jar. The slides were then washed in fresh tap water in a beaker to remove excess stain without impairing milk films and air dried. After this slides were examined under microscope. The cells got stained deep blue against faint blue background.

The determination of number of cells present in each field was made with the microscope, using oil immersion lens of 0.16 mm diameter. The diameter of the field was measured by using a stage micrometer. Then the microscopic factor was determined as follows:

The area of the field was calculated from the formula πr^2. The diameter of the field microscope equipped with 10X ocular and an oil-immersion objective was measured 0.16 mm or 0.016 cm. So, the area of the field = 3.1416 X (0.008)2 = 0.002 sq.cm. and the microscopic factor

$$= \frac{100}{0.002} = 500{,}000$$

This factor multiplied by the average number of cells per field gave the approximate number of cells in 1 ml of milk. The ensuring accuracy, a minimum of 50 fields were counted per slide. The final result was calculated by multiplying the cells per field (average) by the microscopic factor.

Number of somatic cells per ml of milk = Av. number of cells per field x 500,000

Composition and Preparation of stain for S.C.C.

Composition of dye

Methylene blue dye	-	0.6 gm
Ethyl alcohol (95%)	-	54 ml
Tetrachloro ethane	-	40 ml
Glacial Acetic acid	-	6 ml

Preparation of Dye:- Ethyl alcohol (54 ml) and Tetra chloro ethane (40 ml) were mixed in a bottle and heated in a water bath at 60-70°C for 15 minutes. Methylene blue dye was added in the solution carefully and the solution was kept in a refrigerator at 4°C for 30 minutes and then glacial acetic acid was added. The dye solution so prepared was filtered using a filter paper with a pore size of 10-12 μ and was stored in a coloured bottle.

3.6.9 Body Condition Score (BCS)

For recording the body condition of animals, following points were taken into account:-

i) Flesh covering at spinous processes of the shine, loin and rump region.

ii) Prominence of spinous processes

iii) Sharpness of spinous processes.

iv) Prominence of depression in tail head region i.e. between backbone and pins and pin and hook bones.

Considering the above points, a score chart was formulated which has been presented as under:

CONDITION SCORING CHART

Point	Score	Description
i. Vertebral column (chine, loin & rump region)	1	Individual spine very prominent and sharp to touch
	2	Spines prominent,ends sharp but covered with thin layer of muscular tissue.
	3	Spines not prominent but can be felt individually by slight pressure of hand.
	4	Spines not clear individually, rounded in shape, can still be felt with pressure.
	5	Difficult to palpate,covered with thick layer of fat.
	6	Spines burried under fat, impossible to palpate.
ii. Tranverse processes (TP) of lumbar vertebrae	1	Very distinct and sharp to touch, no muscle cover.
	2	Distinct but less sharp, little muscle cover.
	3	Observable but not very sharp, not detectable individually.
	4	Rounded and can be felt only with some pressure.
	5	Rounded with fatty muscle layer, TP can only be felt with firm pressure.

	6	Thick fatty deposition observable. TP not palpable.
iii. Prominence of pins/ Hooks	1	Very sharp to touch, not detectable muscle tissue.
	2	Sharp but covered with little muscular tissue
	3	Pins/Hooks smooth covered with some fatty tissue.
	4	Hooks/Pins well rounded, fatty tissue clearly evident.
	5	Hooks/pins nearly fattened, fatty tissue present all around.
	6	Hooks/pins burried under fatty tissue.
iv. Over hanging shelf effect	1	Definite shelf clearly evident gaunt tucked in.
	2	Shelf effect prominent.
	3	Moderate shelf evident
	4	Slight shelf evident.
	5	No shelf evident
	6	Bulge clearly evident.
v. Tail head region	1	Deep cavity under tail head, clearly visible. Tail vertebrae visible individually,clearly.
	2	Depression not as marked. Tail vertebrae easily palpable singularly.

	3	Depression shallow,vertebra palpable with some pressure.
	4	No depression visible under tail head, slight fatty tissue palpable around tail head.
	5	Individual vertebrae not palpable even with firm pressure. Accumulation of fatty tissue all around easily discernible.
	6	Tail head burried under fatty tissue.
vi. Depression between backbone and hooks/ backbone & pinbones	1	Depression very deep, skin drawn tight over pelvis with no tissue in between
	2	Depression deep with only slight layer of tissue in loin area.
	3	Depression still evident but not as deep.
	4	Flattened slight fatty tissue detectable.
	5.	No depression, fatty tissue clearly visible.
	6.	Heavy deposits of fat over loin area/no depression.
vii. Ribs	1	Individual ribs sharply prominent, no detectable fat cover over ribs,sharp to touch.
	2	Ribs still prominent but covered with thin layer of muscular tissue.
	3	Not all the ribs clearly visible covered with thick layer of muscular tissue.

4	Ribs not clear individually. Palpable with little pressure.
5	Ribs palpable only with firm pressure.
6	Ribs very difficult to palpate, heavy deposits of fat all around.

The chart considered the finer points of the major condition scoring systems in vogue and was thus an improvement over the existing systems. The chart was examined by a panel of experts before it was finally used for experimentation.

Animals were body condition scored on the day of their induction into the experiment at fortnightly intervals.

3.7 STATISTICAL ANALYSIS

The means and standard errors of the results of various tests were computed using Analysis of Variance and Regression analysis. Least square analysis of variance was done for minimising the error in estimates and regression equations were fitted to predict the parameters from related parameters.Statistical procedures and tables were used from Snedecor and Cochren (1967)

Results and Discussion

4. RESULTS AND DISCUSSION

The results obtained in this study have been presented and discussed under different headings as follow:

4.1 BODY WEIGHTS

The mean body weights of animals under different treatment combinations have been presented in Table 1. The body weight ranged from 480 kg to 680 kg in buffaloes categorised for being Hand milked and 489 kg to 675 kg in buffaloes for machine milking. The averages being 612.80±14.81 kg under hand milking and 621.00±12,41 kg under machine milking. The overall mean body weight of buffaloes under observation was found to be 616.90±9.52 kg.

In case of Sahiwal cows under hand milking, the mean body weights of animals ranged between 350 and 490 kg. The least square mean being 415.00±11.95 kg. The cows under category of machine milking had body weights ranging from 355 to 455 kg, the mean being 412.00±13.83 kg. The overall mean body weight of cows under observation was 413.50±8.99 kg. Irrespective of the variation among individual animals of categories, there were no significant variations among treatment combinations for body weights.

The environment provided to animals is standard as per N.D.R.I.norms and the selection of animals was based on perfect healthy condition.

4.2 BODY CONDITION SCORE

The values for least square mean body condition scores are presented in table 2. The body condition score of Murrah buffaloes under hand milking ranged from 3 to 5 at a 6 point scale (Prasad, 1994). The least square mean obtained was 4.47±0.18. The body condition score of buffaloes under machine milking ranged from 3.5 to 5 average being 4.22±0.09. The overall least square mean of body condition score obtained was 4.34±0.10.

These results indicate towards good to very good body condition of the animals.

In case of cows under hand milking the value of body condition score ranged from 3 to 4.75 the mean being 3.83±9.13. For cows under machine milking the body condition score was observed to be from 3.00 to 4.75. The mean value was 3.95±0.13. The overall mean body condition score was 3.89±0.09.The results point towards good body condition. The buffaloes in general had slightly better body condition than cows. The comparison of the categories within species indicates very little initial variation for this parameter.

4.3 UDDER CHARACTERISTICS

Least square means for udder length, udder width, teat length and teat circumference are presented in tables 3 to 6.

4.3.1 Udder Length

The udder length of Murrah buffaloes under hand milking ranged from 40.00 cm to 50.00 cm. The mean udder length was 44.93±0.84 cm.The buffaloes under machine milking had udder lengths varying from 35 cm to 49 cm., the mean udder length being 41.47±1.18 cm.

The udder lengths of cows under hand milking ranged 30-40 cm whereas the udder lengths of cows under machine milking ranged from 31-38 cm. The least square mean value obtained for udder length was 34.40±0.99 cm.and 33.93±0.70 cm under hand and machine milking respectively. The overall mean udder length in cows was 34.17±0.60 cm.

The average udder length within species but between hand v/s machine milking categories did not differ appreciably.

4.3.2 Udder Width

The udder width of Murrah buffaloes under hand milking was observed to range from 25 to 37.5 cm. The least square mean value was 32.37±0.90 cm.The corresponding values for

buffaloes under machine milking ranged from 22 to 35 cm, the average being 27.53±1.45 cm.

The overall mean udder width of buffaloes was 29.95±0.99 cm.The udder widths of Sahiwal cows under hand milking ranged from 19 cm to 26 cm. The mean value was 23.00±0.69 cm. The corresponding range for cows under machine milking was 19 cm to35 cm. The mean value found was 23.80±0.60 cm.

Thus we see that udder width showed the pattern corresponding to udder length in both speciesand there were little variations between categories within species.These results clearly establish that the udders were capacious, the udders of buffaloes being slightly more capacious than those of cows.

4.3.3 Teat Length

The range of teat length for buffaloes under hand milking was 8 cm to16 cm, the least square mean being 14.40±0.65 cm.The range of teat length in buffaloes under machine milking was 10-17 cm.. The least square mean value obtained for teat length was 12.93±0.59 cm.

The teats of Sahiwal cows under hand milking had length ranging from 9 to 15 cm, the mean value being 12.00±0.47 cm. The corresponding range and mean values of cows under machine milking was 8-14 cm and 11.00±0.42 cm respectively. The overall mean teat length of cows was observed as 11.50±0.32 cm.

4.3.4 Teat Circumference

Buffaloes under hand milking system had their teat circumferences ranging from 9-14 cm. The least square mean value for teat circumference was 12.13±0.42 cms.The teat circumference of buffaloes under machine milking ranged from 8 cm to 14 cm. The mean value was 10.80±0.46 cm. The overall mean teat circumference was 11.47±0.33 cm.

The teat circumferences of cows under hand milking were in range of 8-12 cm. The

least square mean value being 10.13±0.36 cm. The corresponding range and mean under machine milking were 8-11 cm and 8.73±0.48 cm respectively.The overall least square mean value for teat circumference was seen 9.43±0.32 cm.

4.4 TEMPERAMENT SCORE

Least square means of temperament score of dairy animals are shown in table 8 . A perusal of data indicates that Murrah buffaloes under machine milking showed somewhat higher score than those under hand milking system. Whereas in case of cows the temperament was more intense in case of hand milked animals than those under machine milking (The mean temperament scores of buffaloes were 3.98±0.09 and 4.23±0.10 and in cows 2.85 and 2.55 under hand and machine milking respectively in a 7 point modified score chart (Mallick, 1993 has reported the mean temperament score of Sahiwal cows as 1.98 on a five point scale).

These results give clue that the Sahiwal cows can easily be put to machine milking than buffaloes with less severe temperamental reactions.

The results of ANOVA indicate significant($P<0.01$) difference between the two species viz, Sahiwal cows and Murrah buffaloes with the buffaloes being more temperamental as compared to Sahiwal cows. However, the variation between milking systems was non-significant. The same was the case with the fortnights (periods). These results clearly establish that there was a significant variation in temperament of the animals (both the Sahiwal cows and Murrah buffaloes) as a result of switch over to machine miking. This clearly establishes that Sahiwal cows as well as Murrah buffaloes can be put to machine milking without significant problems related to the animal temperament. Although the temperament score of Murrah buffaloes was slightly higher in machine milking as compared to their counterparts under hand milking.This,however, was not the case with Sahiwal cows

which to the contrary had somewhat lower (non-significant) temperament score under machine milking. These results are very significant from the point of view that only a very limited number of Sahiwal cows and Murrah buffaloes are milked by machine in our country and these findings could serve as a basis for adoption of machine milking in these species.

The regression analysis was attempted to predict the temperament score of the dairy animals with inclusion of 8 parameters, namely breed, parity, stage of lactation, milking system, body weight, body condition score, letdown time and SCC. It could predict the temperament score of the animals with an accuracy of 57 %.

The temperament score had high correlation with species (r= -0.74), moderate correlations with body condition score (r=0.41), milking time (r=0.38), letdown time (r=0.46), udder length (r=0.43), udder width (r=0.34), teat length (0.39), teat circumference (0.33), somatic cell count (r= -0.33), and low correlations with milking rate(-0.01), body weight (0.01), milking system(0.01), stage of lactation(0.01) and parity(0.04).

These results are in accordance to those obtained by Tulloh (1961) who studied the temperament in Hereford, Angus and Short-horn breeds.The correlation between milking temperament and body condition score supports his doctrine that docile animals have better growth rate. Kudryavtzeb (1962) established the relationship between temperament and milking potential. According to him milking potential was highest in sanguine cows followed by phlegmetic cows. Dickson 1966 and Dickson *et al.* 1970 found the correlation between stage of lactation and temperament to be -0.04. It is difficult to find a valid reason but an increase in environmental stressors might have caused it.

A persistent increase in temperament of animals was noted in buffaloes as well as cows with passage of period of study. Although the variation was not significant but it may be due

to increase in ambient temperature as observed by Gangwar (1983) in a study on Murrah and Nili Ravi buffaloes.He reported that the number of very docile animals was higher in winter than in hot dry or hot humid summer and the mean number of animals in each of the other categories was higher in other temperament categories.

The species differences are also supported by findings of Nayak and Mishra (1984) who reported positive correlation between temperament and duration traits in Red sindhi and cross bred cows and Murrah buffaloes.

4.4.1 Letdown Time

Least square means of letdown time of dairy animals have been shown in table 9. Fortnight-wise values ranged for buffaloes under hand milking from 247.60±12.34 seconds to 344.50±3.43 seconds and the overall mean was found to be 303.32±4.93 seconds. The range of buffaloes under machine milking was 119.27±3.73 seconds to 328.67±4.21 seconds. The overall mean under machine milking was 280.25±8.10 seconds.

The Sahiwal cows under hand milking had mean letdown time 241.53±3.07 seconds and in machine milking it was found 222.49±2.07 seconds.

Alim *et al.* (1977) found that dry hand massaging caused early letdown. Thus their doctrine that stimulation method affects letdown time is further substantiated by these findings. However, these results negate the theory propounded by Lohr and Troger (1977) who reported that letdown time was not significantly influenced by stimulation method, age of the cow and time of milking.

Letdown time was more in Murrah buffaloes than in Sahiwal cows (291.57±2.81 and 232.01±2.81 sec) as found by previous workers (Roy and Nagpal, 1984).

The variation of letdown time between species, between milking systems and between

fortnights was significant as reported by Roy and Nagpaul (1984) .

The letdown time was highly correlated but negatively with body weight (-0.55), breed (-0.52), moderately correlated with temperament score (r = 0.38), udder width (r = 0.43) and lowly correlated with all other parameters, viz., parity (r = 0.01), stage of lactation (r = 0.14), body condition score (r = 0.198), milk yield (r = 0.19), milking time (r = 0.26), teat length (r = 0.24), teat circumference (r = 0.30), somatic cell counts (r = 0.01) and milking rate (r = -0.04).

Similar findings were also obtained by Nayak and Mishra (1984).

when an attempt was made to predict the letdown time by using various related parameters (Breed, parity, stage of lactation, milking system, temperament score, milk yield, udder length, udder width, teat length, teat circumference and somatic cell counts), they could together predict the letdown time to the extent of only 38 %, thereby indicating that other factors may also influence the letdown time of dairy cows/buffaloes.

Alim *et. al.* reported in 1977 that better stimulation method resulted in early let down time. The findings of this study substantiate the same contradicting the view of Lohr and Troger who found that stimulation method did not significantly influence let down time.

4.5 MILK YIELD

The least square means of milk yield have been presented in table 14.

A perusal of data reveals slightly higher overall mean milk yield in machine milking irrespective of any other factor, as the values for buffaloes under hand and machine milking showed the milk yield 5.22±0.22 and 5.43±0.20 kg respectively. The same values for buffalo were 3.93±0.14 as well as 4.04±0.25 kg. This variation might have been caused due to better

stimulation as well as efficient and complete removal of milk in machine milking compared to hand milking.

A decline in milk yield among fortnights is also evident from the table which may be due to summer stress.

The variations in milk yield between milking systems, species and fortnights were highly significant.

The milk yield was found to be highly correlated with milking time (r = 0.78), moderately correlated with species (r = -0.32), and somatic cell count (r = 0.29). The correlations with other parameters were low, viz., parity (r = -0.03), stage of lactation (r = -0.01), milking system (r = 0.04), body weight (r = -0.04), body condition score (r = 0.16), temperament score (r = 0.21).

The regression equation was attempted to predict milk yield from the 9 related parameters, viz., breed, parity, stage of lactation, milking system, body condition score, body weight, temperament score, milking time, letdown time. This could predict the milk yield upto 62%, i.e., milk yield is affected by several other factors.

The findings of Drogociew (1977) and Rahman (1988) and Rai (1991 and 1997) point towards similar observations, however, the relationship between temperament and milking potential are not in complete agreement of the findings of Tulloh (1961), and Kudryavtzeb (1962) who reported that docile cows during milking yield more milk.. The probable cause for this difference can be attributed to other contributing factors.

4.6 MILKING TIME

Least square means of milking time are presented in table 12.

The overall mean milking time of Murrah buffaloes was 487.49±18.72 and 520.78±18.94 second whereas the corresponding value of Sahiwal cows was observed as 369.37±12.11 and 363.05±14.05 second respectively.

Milking time was significantly affected between fortnights (as observed by Shivalkar (1973) and between species (Dash, 1973).

The variation of yields among fortnights might have been caused due to several factors, as advancement of stage of lactation, changes in yield as well as changes in environmental stressors.

Milking time was moderately correlated with temperament (r = 0.30). It is obvious by rational logic that, it is difficult to obtain milk from an aggressive animal causing delay in complete removal of milk.

Similar observations have also been reported by Reddy and Tripathi (1987).

The means obtained are near to those obtained by Bhagat and Shastry (1992).

The milk yield was moderately correlated with breed (r = -0.32), milking rate (r = 0.40). The correlation of milking time and milk yield was high (r = 0.78).

The correlation coefficients obtained with other parameters were low in general.

4.7 MILKING RATE

The least square means of milking rate of dairy animals are presented in table 16.

The value of overall milking rate under machine milking was higher than that under hand milking in case of cows (681.06±42.28 against 650.08±8.9 gm/min). The case was not so in case of buffaloes (695.68±67.84 gm/min in hand and 624.65±5.76 gm/min in machine milking.

This finding is a further support of more suitability of machine milking in case of Sahiwal cows.

Milking rate varied significantly in between species, however, variations between fortnights and between milking systems were non-significant.

Milk secretion rate was moderately correlated with milk yield (r = 0.40). The correlations with other parameters were low.

The observations of Frutus (1984) regarding effect of milking rate on milking technique that cows which had highest milking rate required shortest stimulation was seen by the worker, although statistically significant relationship could not be established.

4.8 SOMATIC CELL COUNT

The least square mean values for somatic cell counts have been presented in table 18.

The overall mean values for Murrah buffaloes under hand and machine milking systems were $0.72x10^5 \pm 0.01$ and 0.76 ± 0.01 $x10^5$/ml respectively.

The cows gave the counts $0.85x10^5$ and $1.04 \pm 0.01x10^5$/ml in respective categories, respectively.

The same pattern has been observed by Ramasami (2001). The values were also in the range of those reported by several workers (Jyotsna and Silva and Silva, 1994; Rupp and Boichard, 2000; Mangwiro et al., 2000; Singh and Ludri, 2001).

Somatic cell count varied significantly between species, between milking systems and between fortnights.

Periodic variation was also observed by Jyotsna and Singh (2001). The probable cause for the increasing trend in the SCC count as obtained in this study, could be attributed to increased stress caused due to the increase in ambient temperature.

The increased count in cows under machine milking can be caused due to increased exertion on teats in machine milking system as there is a considerable variation among the Sahiwal cows and Murrah buffaloes with respect to the shape and size of the teats. Initial adjustment problems or other operational difficulties may also partly explain these variations. The variations, however, were not statistically significant and were particularly narrow in case of Murrah buffaloes.

Somatic cell count (SCC) was found to be moderately correlated with species ($r = 0.49$), body weight ($r = -0.31$), temperament score ($r = -0.33$), udder length ($r = -0.39$), udder width ($r = -0.25$) and teat circumference ($r = -0.35$).

Body weight and Body condition score are indicators of general health. The moderate correlation with these parameters substantiates the rational conclusion that a healthy animal will have less somatic cell count.

The correlations with biometric parameters like udder length, udder width and teat circumference can be of help for finding contributing causes for somatic cell counts. This may be a good area of future investigation.

Under light of aforesaid discussion, following recommendations are made.

(1) Owing to the needs of organised milk production system, machine milking can be safely adopted for Murrah buffaloes and Sahiwal cows.

(2) Sahiwal cows are more suitable for machine milking as they have shown higher milking rate, lower temperament score, more yield under machine milking than hand milking.

(3) The udder characteristics are correlated well with milking parameters as well as somatic cell count. Hence, these should be kept in mind while resorting to machine milking.

(4) The significant variation in somatic cell counts between milking systems indicate that machine milking might result in slight but not significant increase in somatic cell count, hence, machine milking should be done with due care.

(5) The somatic cell count had good association with species, letdown time and udder characteristics, these aspects should be kept in mind while interpreting the effect on somatic cell counts in the milk.

Table 1 : Least squares means for body weights of animals under experiment (kg)

Milking system	Mean weight
Murrah Buffaloes	
a. Hand milking	612.80±14.81 (480 - 680)
b. Machine milking	621.00±12.41 (489-675)
c. Overall mean	616.90±09.52
Sahiwal cows	
a. Hand milking	415.00±11.95 (350-490)
b. Machine milking	412.00±13.83 (355- 455)
c. Overall mean	413.50±08.99

Table 2 : Least squares means for body condition score of animals under experiment

Milking System	Mean score
Murrah Buffaloes	
a. Hand milking	4.47±0.18 (3.0-5.0)
b. Machine milking	4.22±0.10 (3.5-5.0)
c. Overall mean	4.34±0.10
Sahiwal cows	
a. Hand milking	3.83±0.13 (3.0-4.75)
b. Machine milking	3.95±0.13 (3.00-4.75)
c. Overall mean	3.89±0.09

Table 3 : Least squares means of udder length of animals under experiment

Milking System	Udder Length
Murrah Buffaloes	
a. Hand milking	44.93±0.08 (40-50)
b. Machine milking	41.46±1.18 (35-49)
c. Overall mean	43.20±0.79
Sahiwal cows	
a. Hand milking	34.40±-0.98 (30-40)
b. Machine milking	33.93±0.70 (31-38)
c. Overall mean	34.16±0.59

Table 4 : Least squares means of udder width of animals under experiment (cm)

Milking System	Udder width
Murrah Buffaloes	
a. Hand milking	32.37±0.97 (25-37)
b. Machine milking	27.53±1.45 (22-35)
c. Overall mean	29.95±0.99
Sahiwal cows	
a. Hand milking	23.00±0.69 (19-26)
b. Machine milking	24.60±0.97 (19-35)
c. Overall mean	23.80±0.09

Table5 : Least squares means of teat length of animals under experiment(cm)

Milking System	Teat length
Murrah Buffaloes	
a. Hand milking	14.40±0.65 (8-16)
b. Machine milking	12.93±0.59 (10-17)
c. Overall mean	13.67±0.45
Sahiwal cows	
a. Hand milking	12.00±0.47 (9-15)
b. Machine milking	11.00±0.42 (8-14)
c. Overall mean	11.50±0.32

Table 6 : Least squares means of teat circumference of animals under experiment(cm)

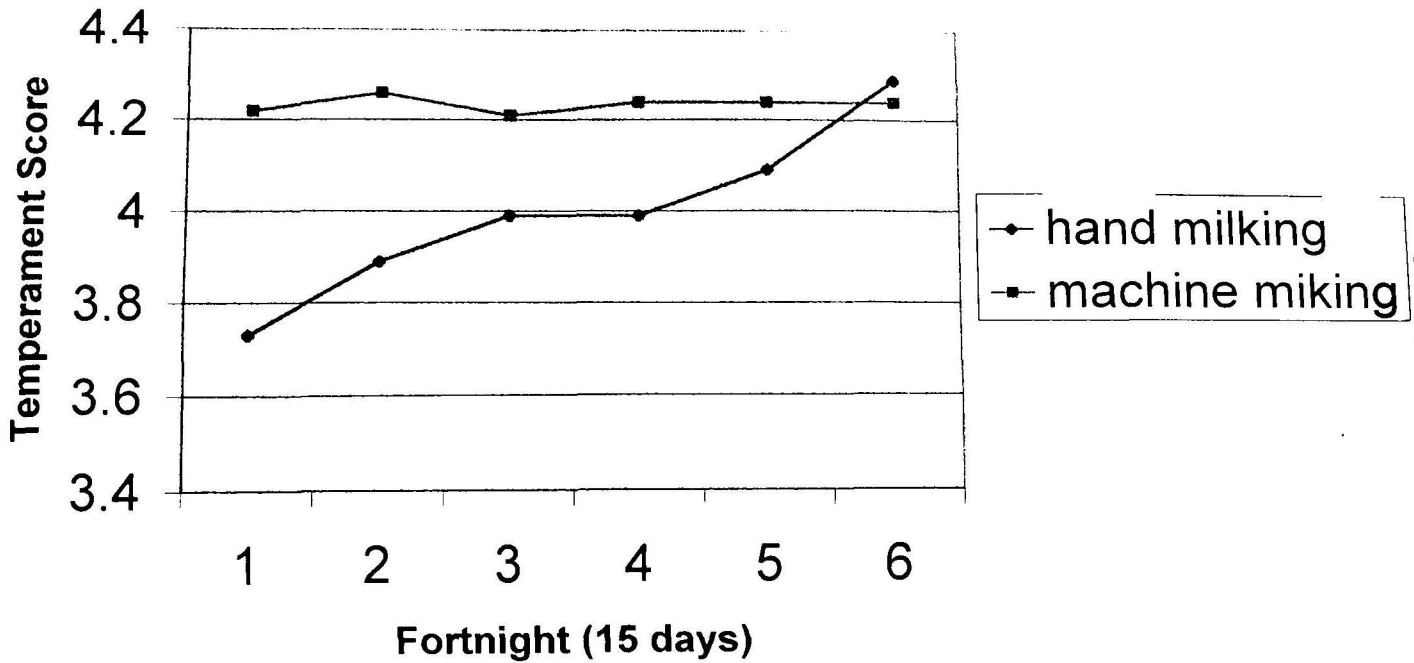
Milking System	Teat circumference
Murrah Buffaloes	
a. Hand milking	12.13±0.42 (9-14)
b. Machine milking	10.80±0.33 (8-14)
c. Overall mean	11.47±0.33
Sahiwal cows	
a. Hand milking	10.13±0.36 (8-12)
b. Machine milking	08.73±0.48 (8-11)
c. Overall mean	09.43±0.32

Table 7 : Mean sum squares of ANOVA for Body weight, Body condition score and udder characteristics of dairy animals

Effects	Degrees of freedom	Mean squares					
		Body weight	Body condition	Udder length	Udder width	Teat length	Teat circumsference
Species	1	620573.44**	3.10**	1224.02**	567.34**	70.42**	62.02**
Milking system	1	101.400(NS)	0.63(NS)	5801.02**	39.21(NS)	22.82**	28.02**

**Highly significant
NS= Non-significant

Least square means of temperament scores Murrah Buffaloes under hand and machine milking systems



Least square means of temperament score of Sahiwal cows under hand and machine milking systems

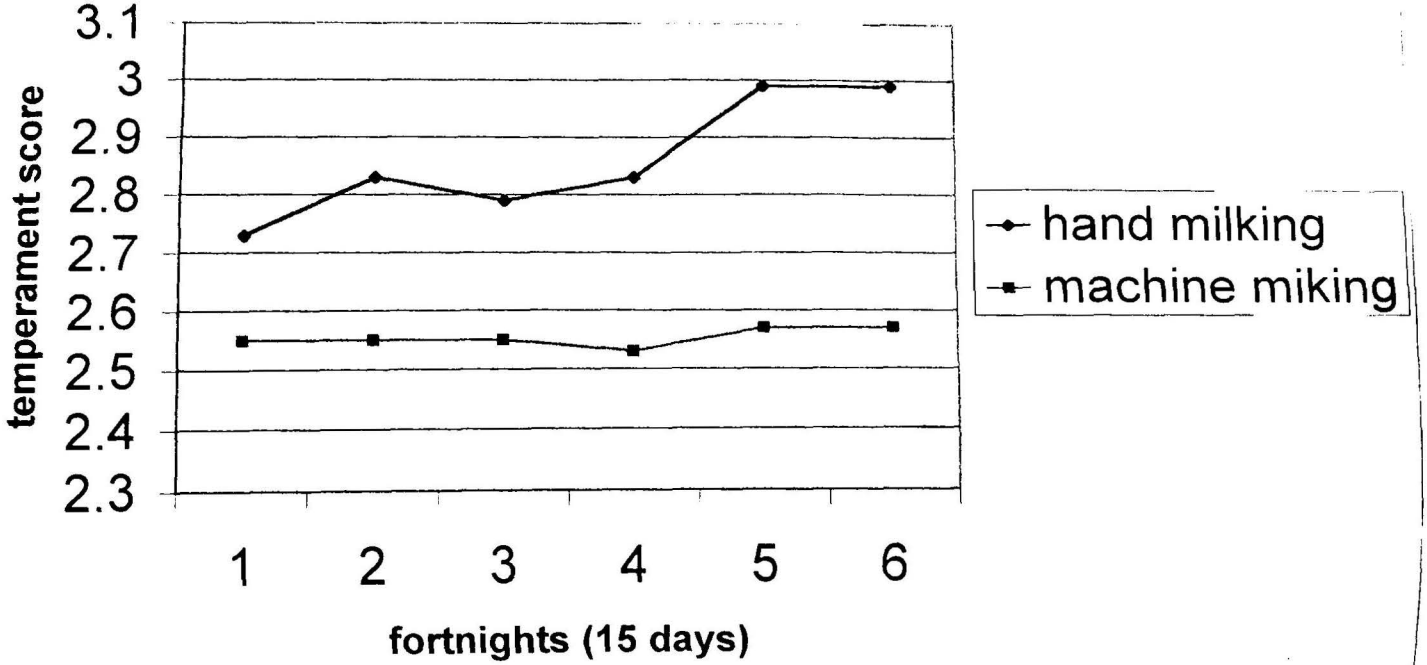


Table 8 : Least square means of temperament score of dairy animals under machine and hand milking system

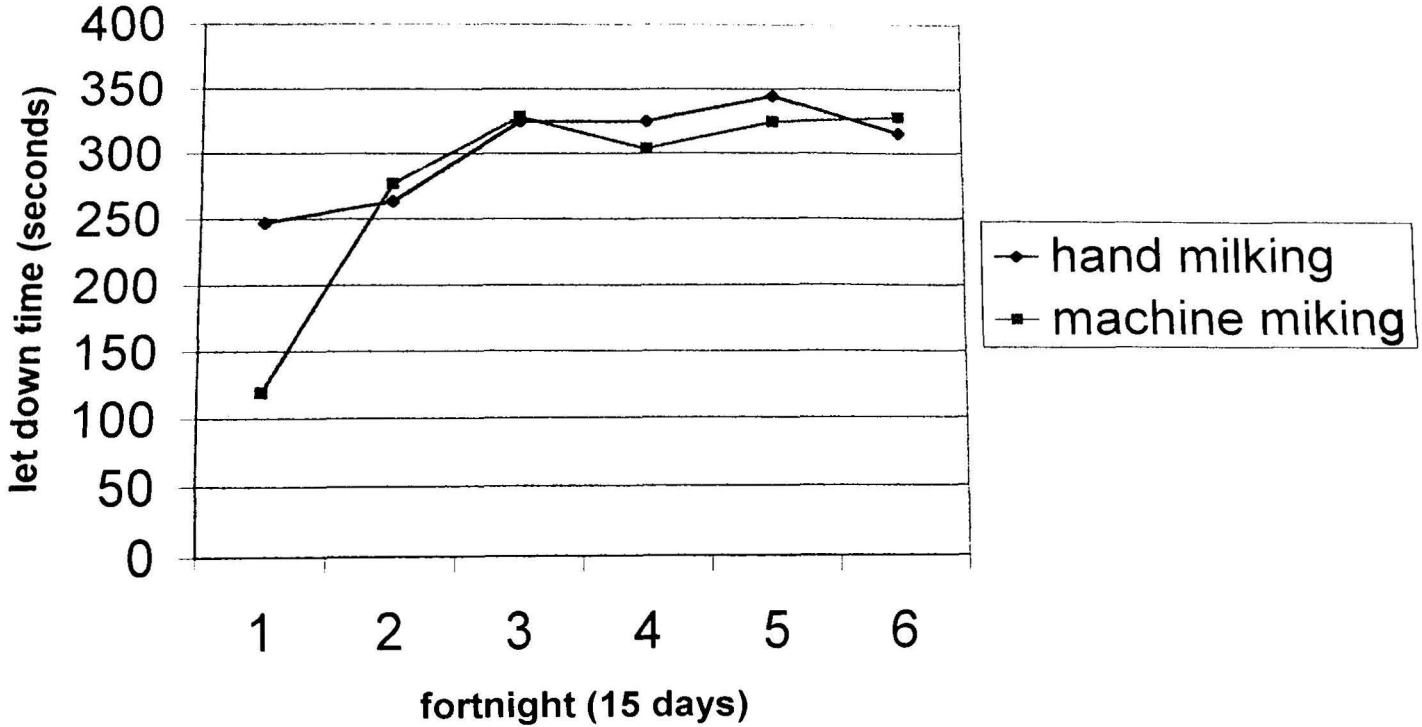
Milking System	FORTNIGHTS						OVERALL
	1	2	3	4	5	6	
MURRAH BUFFALOES							
Hand milking	3.73 ± 0.10	3.90 ± 0.26	3.99 ± 0.23	3.99 ± 0.24	4.01 ± 0.25	4.29 ± 0.30	3.98 ± 0.09
Machine "	4.22 ± 0.56	4.26 ± 0.12	4.21 ± 0.14	4.24 ± 0.14	4.24 ± 0.14	4.24 ± 0.14	4.23 ± 0.06
SAHIWAL COWS							
Hand milking	2.73 ± 6.12	2.83 ± 0.13	2.79 ± 0.13	2.83 ± 0.13	2.99 ± 0.19	2.99 ± 0.19	2.86 ± 9.96
Machine "	2.55 ± 0.13	2.55 ± 0.09	2.55 ± 0.09	2.53 ± 0.09	2.57 ± 0.08	2.57 ± 0.08	2.56 ± 0.03

Table 9: Mean sum squares of temperament score

Parameter	d.f.	MSS
Between breeds	1	177.22**
Between milking systems	1	0.08(NS)
Between fortnights	5	0.32(NS)
Error	352	0.42

NS = Non-significant
**P<0.01

Least square means of Let down time of Murrah buffallo under hand and machine milking system



Least square means of let down time of Sahiwal cows under hand and machine milking systems

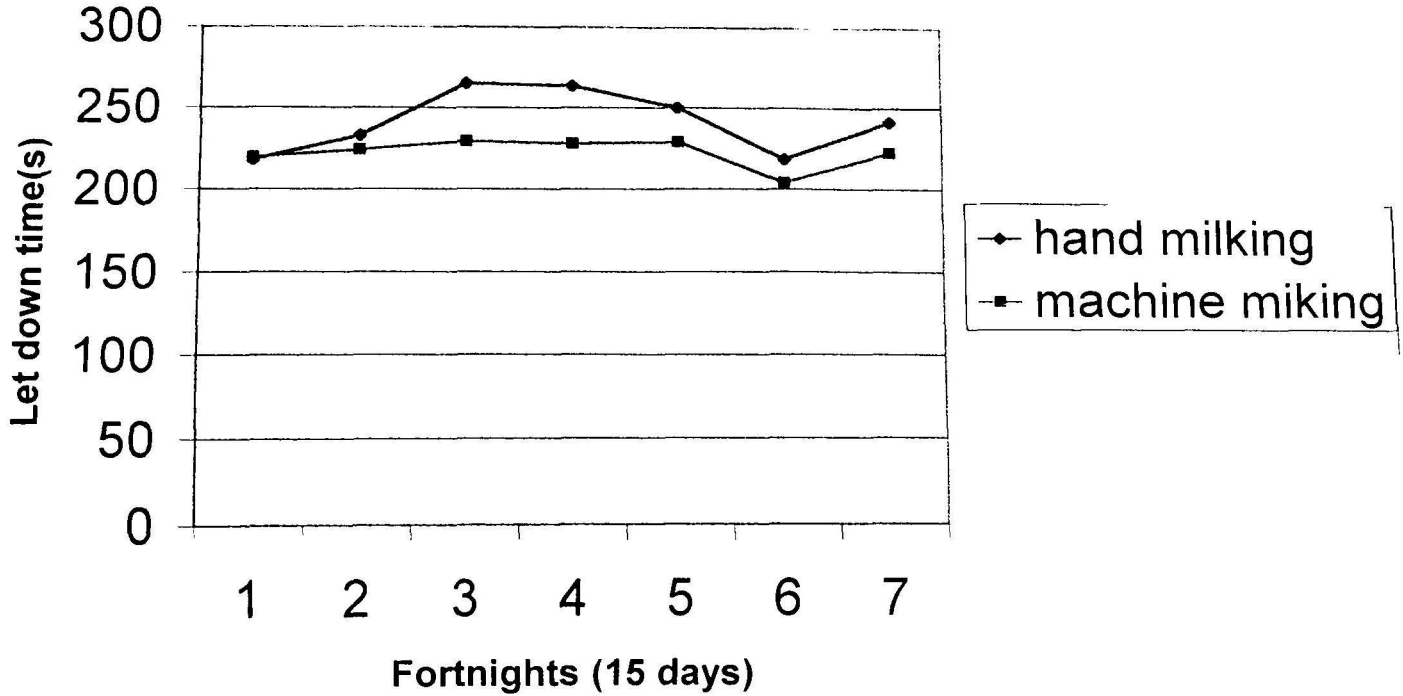


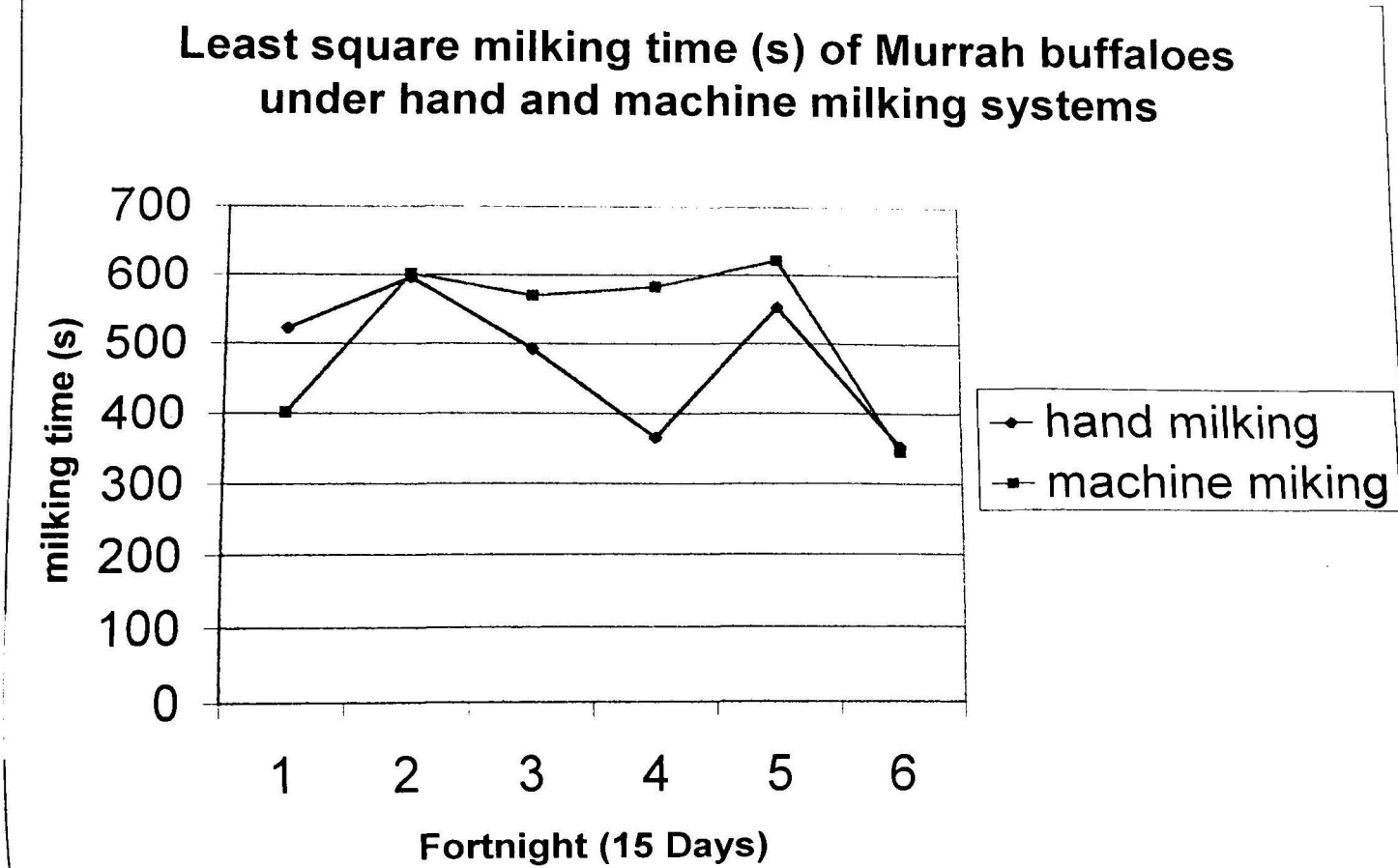
Table 10: Least square means of letdown time of dairy animals under machine and hand milking system (secs)

Milking System	FORTNIGHTS						OVERALL
	1	2	3	4	5	6	
MURRAH BUFFALOES							
Hand milking	247.60 ± 12.34	263.19 ± 12.09	324.81 ± 3.74	324.54 ± 4.30	344.50 ± 3.43	315.09 ± 3.72	303.32 ± 4.93
Machine milking	119.27 ± 3.73	297.07 ± 7.69	328.67 ± 4.21	303.67 ± 1.52	324.60 ± 2.37	328.27 ± 6.31	280.25 ± 8.10
SAHIWAL COWS							
Hand milking	219.73 ± 3.90	233.20 ± 5.78	265.13 ± 8.70	263.67 ± 8.70	250.13 ± 6.67	218.47 ± 2.74	241.53 ± 3.09
Machine milking	219.73 ± 3.90	224.90 ± 3.49	229.47 ± 2.55	228.20 ± 2.78	228.89 ± 1.76	204.27 ± 9.22	222.49 ± 2.07

Table 11: Mean sum squares of letdown time

Parameter	d.f.	MSS
Between breeds	1	318909.28 **
Between milking systems	1	39025.5**
Between fortnights	5	66177.46**
Error	352	1422.44

**P<0.01


Least square milking time (s) of Murrah buffaloes under hand and machine milking systems
700
600
500
400
300
200
100
0
milking time (s)
1
2
3
4
5
6
Fortnight (15 Days)
hand milking
machine miking

Least square mean milking time of Sahiwal cows under hand and machine milking systems

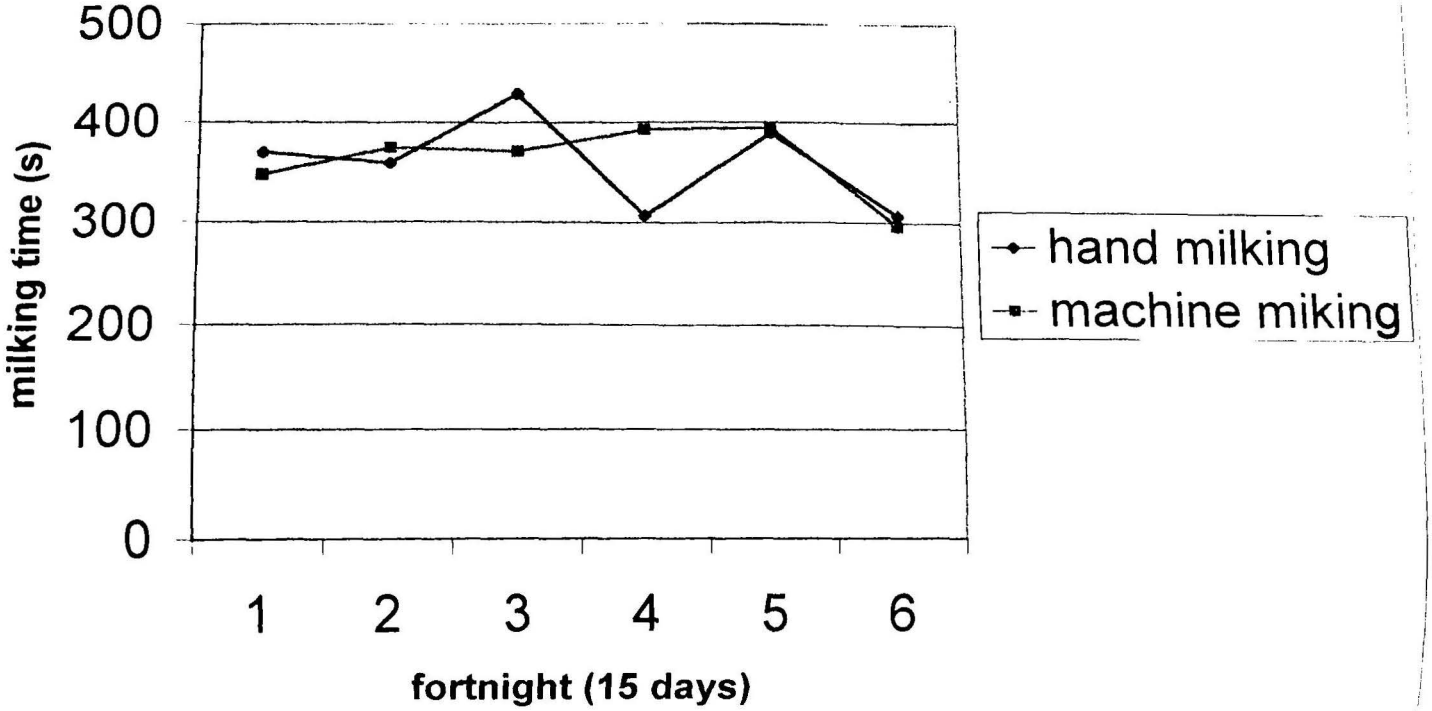


Table 12: Least square means of milking time of dairy animals under hand & machine milking systems (secs)

Milking System	FORTNIGHTS						OVERALL
	1	2	3	4	5	6	
MURRAH BUFFALOES							
Hand milking	522.67 ± 47.95	596.94 ± 55.75	492.63 ± 40.89	366.31 ± 28.47	553.00 ± 28.93	353.27 ± 25.00	487.42 ± 18.72
Machine milking	402.00 ± 44.55	602.27 ± 55.71	569.87 ± 28.96	582.87 ± 28.96	622.13 ± 22.93	345.53 ± 38.49	520.73 ± 18.94
SAHIWAL COWS							
Hand milking	370.07 ± 35.90	359.00 ± 24.62	429.27 ± 44.41	307.13 ± 18.69	389.13 ± 12.41	307.47 ± 20.45	360.34 ± 12.11
Machine "	347.93 ± 42.53	374.60 ± 26.21	371.27 ± 43.50	392.87 ± 40.14	394.73 ± 25.97	296.93 ± 19.37	363.05 ± 14.05

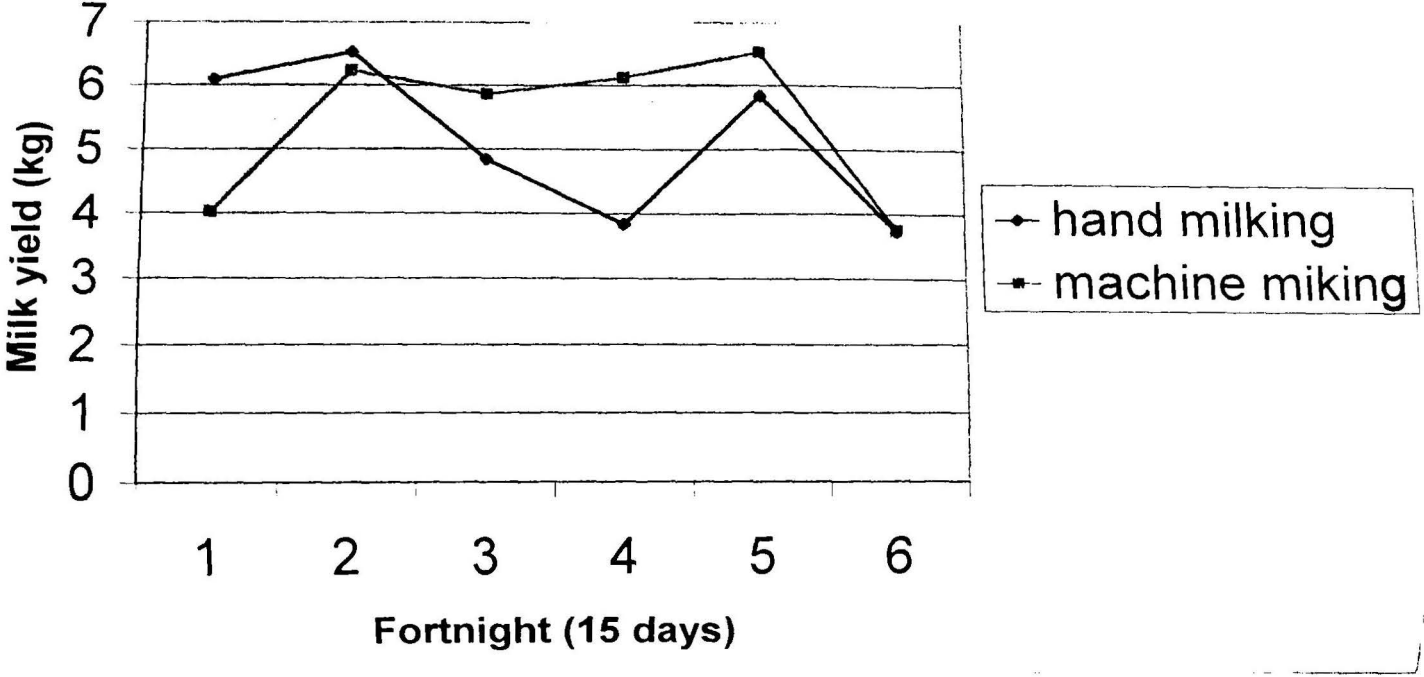
Table 13: Mean sum squares of milking time

Parameter	d.f.	MSS
Between breeds	1	1747561.2**
Between milking systems	1	39723.38(NS)
Between fortnights	5	20917.30(NS)
Error	352	20917.3

NS = Non-significant

**P<0.01

Least square means of milk yield of Murrah buffalloes under hand and machine milking systems



Least-square means of Milk yield of Sahiwal Cows under hand and machine milking systems

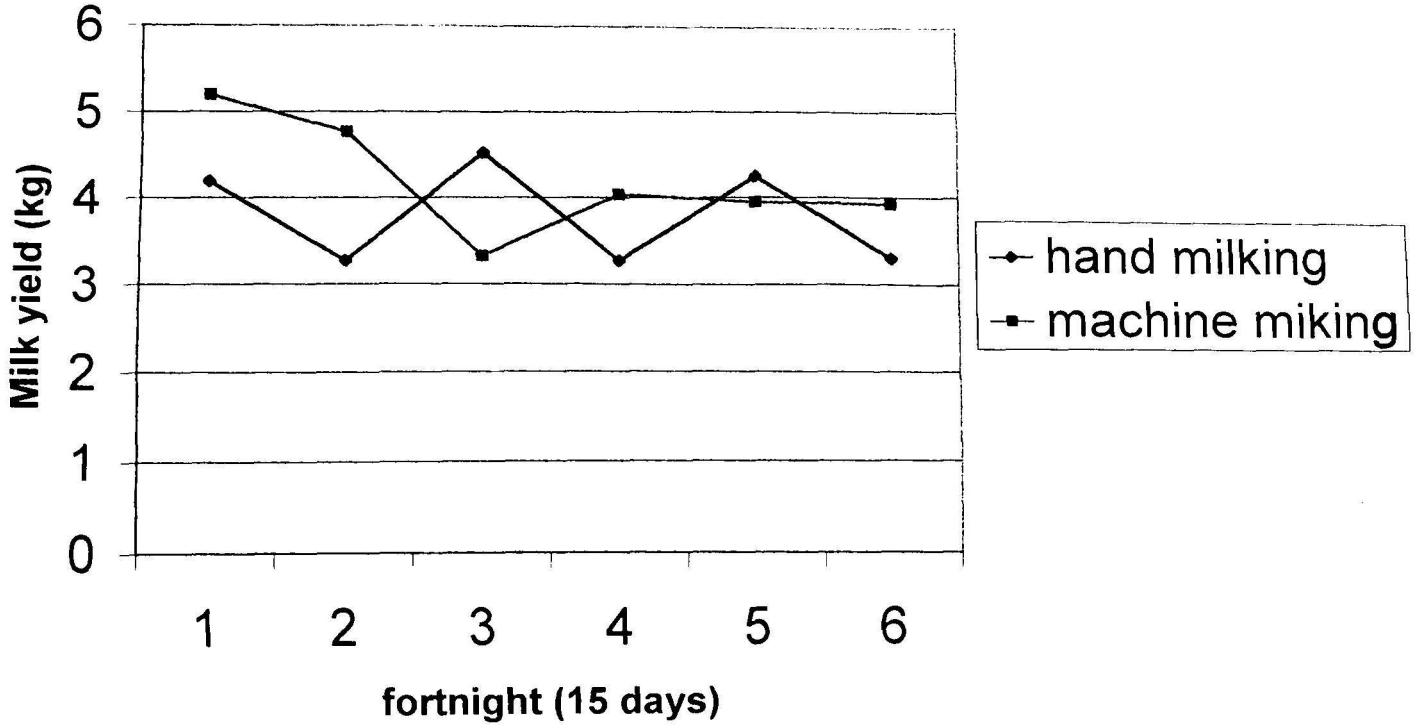


Table 14: Least square means of milk yield of dairy animals under machine and hand milking system(kg)

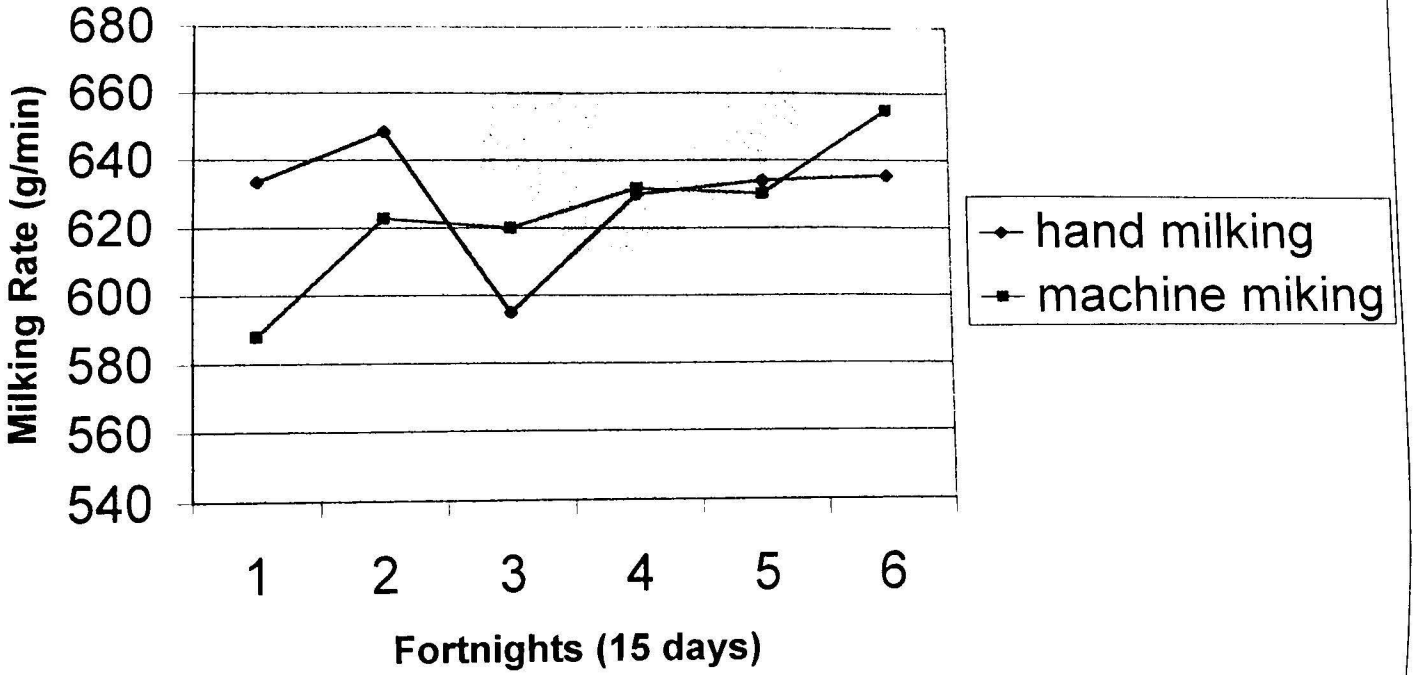
Milking System	FORTNIGHTS						OVERALL
	1	2	3	4	5	6	
MURRAH BUFFALOES							
Hand milking	6.10 ± 0.51	6.53 ± 0.71	4.84 ± 0.43	3.84 ± 0.30	5.84 ± 0.30	3.74 ± 0.28	5.22 ± 0.22
Machine "	4.03 ± 0.50	6.23 ± 0.58	5.87 ± 0.36	6.13 ± 0.31	6.53 ± 0.23	3.77 ± 0.41	5.43 ± 0.20
SAHIWAL COWS							
Hand milking	4.20 ± 0.51	3.83 ± 0.25	4.53 ± 0.47	3.27 ± 0.19	4.25 ± 0.12	3.30 ± 0.23	3.93 ± 0.14
Machine "	5.20 ± 0.47	4.07 ± 0.26	3.32 ± 0.46	4.04 ± 1.33	3.95 ± 0.27	3.93 ± 0.21	4.04 ± 0.26

Table 15: Mean sum squares of milk yield

Parameter	d.f.	MSS
Between breeds	1	156.79(NS)
Between milking systems	1	3.88**
Between fortnights	5	20.51**
Error	352	3.65

NS = Non-significant
**P< 0.01

Least square means of milking rate of Murrah buffaloes under hand and machine milking systems



Least square means of milking rate of Sahiwal cows under hand and machine milking systems

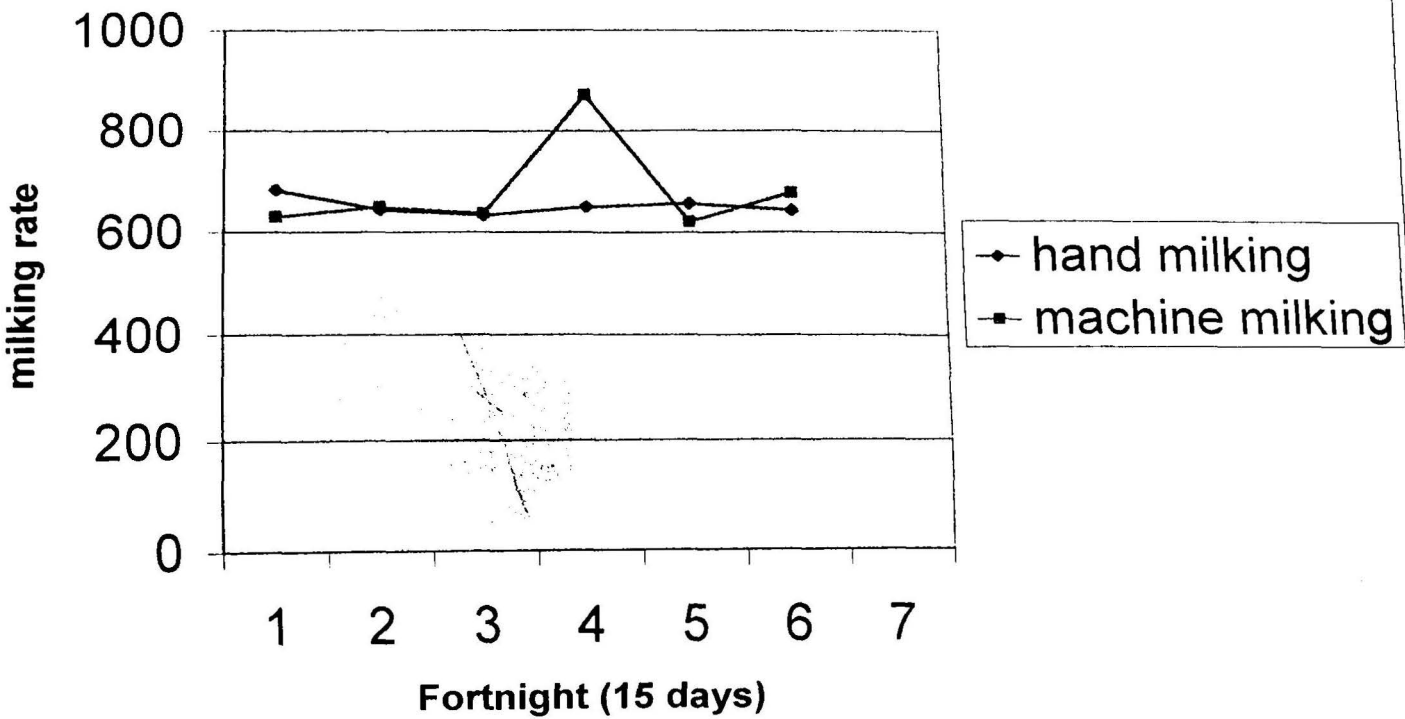


Table 16 : Least square means of milking rate of dairy animals under hand and machine milking systems (gm/minute)

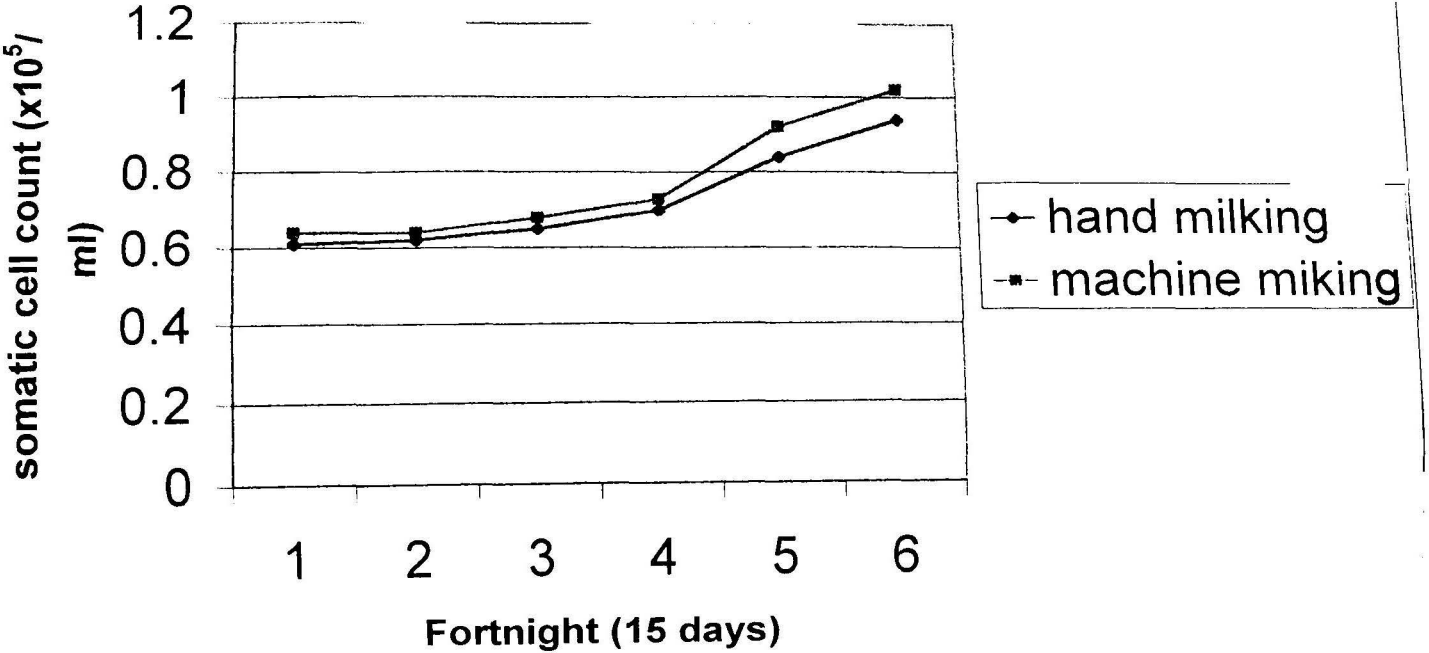
Milking System	FORTNIGHTS						OVERALL
	1	2	3	4	5	6	
MURRAH BUFFALOES							
Hand milking	633.48 ± 405.11	648.44 ± 16.38	595.06 ± 30.57	630.06 ± 4.03	633.92 ± 3.62	635.39 ± 11.80	695.68 ± 67.84
Machine "	588.12 ± 19.92	622.84 ± 07.84	620.05 ± 23.49	631.77 ± 2.58	630.13 ± 4.05	654.99 ± 8.05	624.65 ± 5.76
SAHIWAL COWS							
Hand milking	682.49 ± 61.53	643.50 ± 4.45	633.38 ± 4.29	664.99 ± 5.13	657.08 ± 5.74	643.08 ± 10.34	650.08 ± 8.19
Machine "	630.74 ± 8.19	648.80 ± 4.06	636.95 ± 5.70	871.41 ± 253.91	621.48 ± 11.90	677.02 ± 14.61	681.06 ± 42.28

Table 17: Mean sum squares of Milking Rate

Parameter	d.f.	MSS
Between breeds	1	2485.04(NS)
Between milking systems	1	36605.80(NS)
Between fortnights	5	108270.75(NS)
Error	352	147686.35(NS)

NS = Non-significant

Least square means of Somatic cell count of Murrah buffalloes under hand and machine milking systems



Least square means of somatic cell counts of Sahiwal Cows under hand and machine milking systems

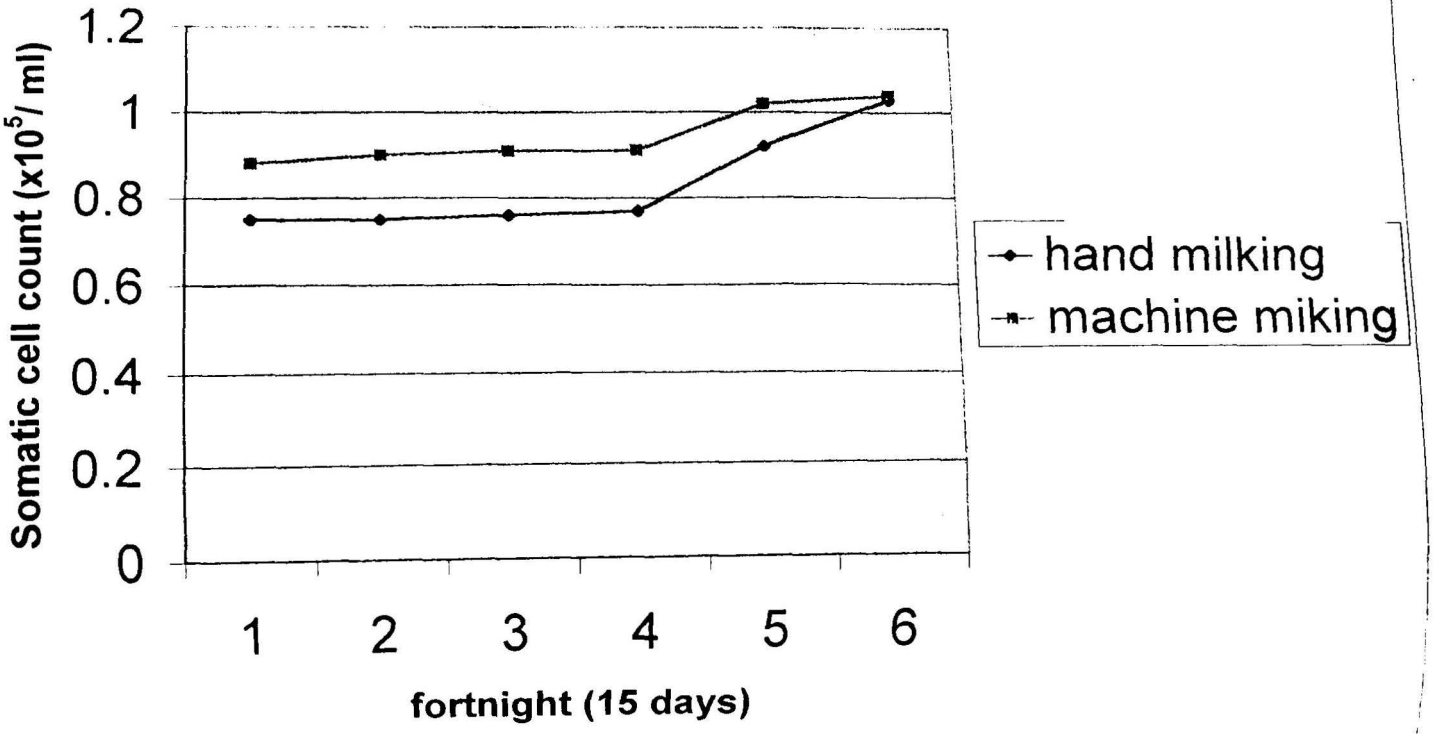


Table 18: Least square means of somatic cell counts of dairy animals under hand and machine milking systems

Milking System	FORTNIGHTS						OVERALL
	1	2	3	4	5	6	
MURRAH BUFFALOES($X10^5$/ml)							
Hand milking	0.61 ± 0.01	0.62 ± 0.01	0.65 ± 0.01	0.70 ± 0.01	0.84 ± 0.01	0.94 ± 0.01	0.72 ± 0.01
Machine "	0.64 ± 0.01	0.64 ± 0.003	0.68 ± 0.01	0.73 ± 0.01	0.92 ± 0.02	1.02 ± 0.02	0.76 ± 0.01
SAHIWAL COWS							
Hand milking	0.75 ± 0.01	0.75 ± 0.01	0.76 ± 0.01	0.77 ± 0.01	0.92 ± 0.01	1.03 ± 0.01	0.85 ± 0.02
Machine "	0.88 ± 0.01	0.90 ± 0.01	0.91 ± 0.01	0.91 ± 0.01	1.02 ± 0.62	1.04 ± 0.02	1.04 ± 0.01

Table 19: Mean sum squares of somatic cell count

Parameter	d.f.	MSS
Between breeds	1	1.03**
Between milking systems	1	0.03**
Between fortnights	5	0.5(NS)
Error	352	0.002

NS = Non-significant

**P<0.01

Table 20: Species, Milking system and Period wise Least square means of certain observed parameters

	Temperament score	Milkyield (kg)	Milking time (secs)	Letdown time (secs)	SCC ($x10^5$/ml)	Milking rate (gm/min)
1.SPECIES						
Murrah buffalo	4.11±0.048	5.29±0.01	501.11±10.79	291.57±2.81	0.75±0.003	660.31±28.67
Sahiwal cows	2.71±0.05	3.97±0.02	361.70±10.78	232.01±2.81	0.89±0.004	665.58±28.64
2. MILKING SYSTEM						
Hand milking	3.42±0.05	4.53±0.02	420.90±10.79	272.20±2.81	0.78±0.004	673.04±28.67
Machine milking	3.39±0.05	4.74±0.02	441.92±10.78	251.37±2.81	0.87±0.003	652.86±28.64
3. FORTNIGHTS						
1	3.31±0.08	4.51±0.02	410.67±18.52	201.17±4.87	0.74±0.01	733.71±49.61
2	3.38±0.08	5.18±0.02	484.09±18.52	249.03±4.83	0.75±0.01	640.90±49.21
3	3.38±0.08	4.78±0.01	465.23±18.52	286.98±4.30	0.77±0.01	620.81±49.21
4	3.41±0.08	4.59±0.01	410.57±18.52	280.19±4.83	0.94±0.01	692.39±49.21
5	3.47±0.08	5.17±0.01	489.82±18.52	287.44±4.83	1.00±0.01	654.38±51.39
6	3.52±0.08	3.55±0.01	328.07±19.34	265.92±4.83	0.72±0.01	654.38±51.39
Overall	3.41±0.08	4.63±0.01	431.41±0.076	261.79±1.99	0.83±0.01	662.95±20.26

Table 21 : Regression equations for predicting different parameters with related observed parameters.

Parameter		Equation	R^2
Y_1(Milking Temperament)	=	4.561-0.756 Breed + 0.67 Parity - 0.31 Stage of lactation +0.009 Milking system - 0.066 Body weight + 0.139 Body condition score -0.071 Letdown time + 0.042SCC	0.5692
Y_2(Milk Yield)	=	-0.104-0.033Breed + 0.059 Parity - 0.025 Stage of Lactation + 0.036 milking system + 0.009 Body weight + 0.049 Body condition score - 0.049 Temperament score - 0.775 milking time + 0.001 Letdown time - 0.004SCC	0.6187
Y_3(Milking Time)	=	692.225 - 0.437Breed + 0.088 Parity - 0.790 Stage of Lactation + 0.160 Milking system - 0.054 Temperament score - 0.084 Udder length + 0.066 Udder width - 0.027 Teat length + 0.080 Teat circumference - 0.115SCC	0.2120
Y_4(Letdown time)	=	341.140-0.675Breed+0.018Parity+0.079State of lactation-0.304Milking system -0.028Temperament score+0.075Milk yield+0.026Udder length-0.046Udder width-0.064Teat length+0.016Teat circumference+0.294SCC	0.3779
Y_5(SCC)	=	0.1968+0.6375Breed-0.078Parity+0.205Stage of Lactation+0.182Milking system-0.017Body condition score+0.082Temperament score-0.084Milk yield-0.022Udder length+0.143Udder width-0.018Teat length-0.035Teat circumference+0.023milking rate	0.3663

Table 22. Correlation Matrix (Lower Half)

X_3	1.0000														
X_4	0.2240	1.0000													
X_5	-0.1842	-0.1168	1.0000												
X_6	0.0000	-0.3462	0.3820	1.0000											
X_7	0.0734	-0/0280	-0.2206	-0.0007	1.0000										
X_8	-0.3858	-0.0421	-0.0581	-0.0949	-0.0771	1.0000									
X_9	-0.7367	-0.1071	0.1088	-0.0144	-0.0988	0.4093	1.0000								
X_{10}	-0.3249	0.0250	-0.0097	0.0426	0.0480	0.1658	0.2158	1.0000							
X_{11}	-0.4207	-0.0268	-0.0168	0.0533	-0.0824	0.1649	0.2970	0.7827	1.0000						
X_{12}	-0.5192	-0.0.0483	0.1380	-0.1829	-0.5466	0.2334	0.3775	0.1946	0.2605	1.0000					
X_{13}	-0.7676	-0.1770	0.0966	-0.1671	-0.0643	0.3128	0.4627	0.2271	0.2959	0 4340	1.0000				
X_{14}	-0.7670	0.0317	0.0128	-0.1502	-0.0486	0.3841	0.4172	0.2247	0.2642	0.3233	0.6918	1.0000			
X_{15}	-0.5715	0.0317	-0.0484	-0.2588	-0.0259	0.4276	0.3396	0.1651	0.2010	0.2424	0.4725	0.3222	1.0000		
X_{16}	-0.4517	0.0563	-0.0457	-0.3355	-0.0255	0.3334	0.3945	0.1722	0.2348	0.2972	-0.5013	0.3869	0.7943	1.0000	
X_{17}	0.4869	0.0665	0.1744	0.2701	-0.3106	-0.1391	-0.3292	-0.2336	-0.2866	0.0964	-0.3940	-0.2477	-0.3038	-0.3462	1.0000
X_{18}	0.0071	-0.0255	-0.0650	0.0262	0.0935	0.0902	-0.0133	0.4031	-0.1261	-0.0448	-0.0003	0.0667	0.0235	0.0231	-0.0205
	1.0000														

X_3=Breed. X_4= Parity, X_5=Stage of lactation. X_6=Milking system, X_7=Body weight
X_8=Body condition score, X_9=Temperament, X_{10}=Milk yield,X_{11}=Milking time,
X_{12}=Letdown time, X_{13}=Udder length.X_{14}=Udder width,X_{15}=Teat length,
X_{16}=Teat circumference,X_{17}=Somatic cell count, X_{18}=Milking rate

CHAPTER -5

Summary & Conclusion

5. SUMMARY AND CONCLUSION

Machine milking as an alternative of hand milking has always fancied the attention of he dairy managers. In future, machine miking is likely to replace hand milking especialkly at anised dairy farms. Murrah buffaloes and Sahiwal cows being two main indigenous breeds was necessary to find out whether the machine milking can be safely resorted to in these imals also as already being done in exotic and crossbred dairy cows in our country. omatic cell count is considered to be the most accurate test for udder health. The quick and omplete milking process is based on the milking temperament of animals. The temperament f the animals has been reported to affect the letdown time, milk yield, milking time and milk low rate of dairy animals. Hence, the worker was interested in studying these temperamental arameters under machine and hand milking environments.

In the backdrop of the above information and in view of the fact that omparisons of this nature have not been made, the present investigation was planned to probe to this problem with the following major objectives:

) To study the milking temperament of Sahiwal cows and buffaloes under hand and achine milking environments.

) To compare the somatic cell count of Sahiwal cows and Murrah buffaloes under hand id machine milking environments.

) To make recommendations on milking management of Sahiwal cows and Murrah ffaloes.

The study was conducted on 30 Murrah buffaloes and 30 Sahiwal cows, from 15th January to 15th April at N.D.R.I. Cattle Farm selected on the basis of soundness of health and negative reaction to Modified California Mastitis Test.

During the experiment the animals were maintained according to standard practices being followed at N.D.R.I. The animals were reared in loose housing condition in open paddocks with tree sheds. Water and roughages were offered ad libitum whereas the concentrates were offered during milking. Every procedure for hygienic rearing and milking operations were personally monitored to ensure least contamination. During milking operation, the pulsation rate and pressure were maintained at optimum to reduce friction/injury. The animals of every species were divided into two categories of 15 animals each for two milking systems viz. Hand milking and Machine milking. The animal number, parity, stage of lactation, date of calving etc. were noted from records. The body weight was recorded as displayed over the weigh bridge. The body condition score and temperament score were noted down periodically with the help of score charges as shown in the chapter on materials and methods.

Milking parameters were observed periodically during milking time. The parameter of milking rate was derived by dividing milk yield with milking time. The animals were screened for absence of clinical/subclinical mastitis based on Modified California Mastitis Test. The milk samples were collected and fixed. After following the staining procedure, these were observed under oil immersion microscope.

Somatic cell counts were observed in 50 fields at random in each slide and their average was multiplied with multiplication factor to arrive at the somatic cell count of the milk sample.

The mean body weights of buffaloes under hand milking was 612.8 kg and udder machine milking 616.90 kg. The weights of cows were 415 and 412 kg respectively. The body condition score of buffaloes 4.47 and 4.12 in hand and machine milking respectively. The body condition score observed for cows under hand milking and under machine milking was 3.83 and 3.95 respectively. The udder length of buffaloes under hand milking averaged 44.93 cm and udder machine milking it averaged 41.47 cm. The corresponding values for cows were 34.40 and 33.93 under hand and machine milking categories respectively. The udder widths of Sahiwal cows and Murrah buffaloes under hand and machine milking averaged 23.00 cm and 23.80 cm (Sahiwal) and 32.37 and 27.53 cm (Murrah) respectively. The teat length of buffaloes under hand milking and under machine milking were 14.4 and 13.67 cm respectively. The teat lengths of Sahiwal cows under hand and machine milking were 12.00 and 4.50 cm respectively. Teat circumferenceof buffaloes under hand milking was 12.13 cm and under machine milking 10.80 cm. The values for Sahiwal cows were 10.13 and 8.73 cm respectively.

Average temperament score of buffaloes was 3.98 and 4.23 in hand milking and machine milking respectively in 7-point modified scale. The values observed for cows were 2.85 and 2.55 respectively. The temperament score was found to be well correlated with species (- 0.74), body condition score (0.41) , milking time(0.38) , letdown time(0.46), somatic cell count (-0.33) and different udder characteristics.

The letdown time in buffaloes under hand milking was 303.12 sec and in machine milking 328.06 sec. The values for cows were 241.5 and 222.49 sec respectively. The letdown time was correlated with body weight and temperament score.

The milk yield in buffaloes was 5.22 and 5.43 kg respectively in hand and machine milking. The corresponding values in case of Sahiwal cows averaged 3.93 and 4.04 kg respectively.

The milk yield varied significantly ($P<0.05$) between species and among fortnights. Variation in milk yield among fortnights might be attributed to the environmental variations.

Mean milking times of the two species under hand and machine milking systems were 487.49 and 520.78 sec.(Murrah) and 369.37 and 363.05 sec. (Sahiwal). Milking time was not influenced by the milking systems. However, the variation was significant among fortnights and between species.

Mean values for milking rate in case of Murrah buffaloes under hand vs machine milking were 695.68 and 624.65 g/min. The corresponding values in case of Sahiwal cows averaged 650.08 and 681.06 g/min respectively. The value of milking rate was slightly higher in machine milking in case cows whereas the trends in milking rate were opposite in case of Murrah buffaloes. The variation, however, was not significant statistically.

The somatic cell count of Murrah buffaloes and Sahiwal cows under hand and machine milking systems averaged 0.72×10^5 and 0.76×10^5 (Murrah) and 0.85×10^5 and 1.04×10^5 (Sahiwal) per ml. respectively. The values were slightly higher in machine milking vis a vis hand milking which may be due to increased friction due to the variable teat size in these two species resulting in secretion of epithelial cells. The variation however, was more in Sahiwal cows as compared to Murrah buffaloes.

CONCLUSION

1. Machine milking can be resorted to, in case of Murrah buffaloes or Sahiwal cows at organised farms without appreciable adverse effect on milk qualitatively or quantitatively.

2. The more milking rate of cows under machine milking indicates more suitability of Sahiwal cows for machine milking.

3. Udder characteristics affect milking parameters as well as somatic cell count.

4. Milking system influences letdown time.

5. Milking time varies significantly between species and periods.

6. The variation of milk yields according to milking system was pronounced.

7. The letdown time is correlated with body weight and temperament score.

8. The temperament score is correlated with species, body condition score, milking time, letdown time, milking rate, udder characteristics and somatic cell counts.

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