Evaluating Milking Performance in Wisconsin and Italy

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Summary

Studies are underway to better understand the relationship between milking machines and management practices on milking parlor performance and efficiency and teat condition. This review will help dairy managers, facility designers and dairy consultants understand the aspects of milking machines and management that are correlated to the efficient production of quality milk. The data presented here was collected on over 80 farms that took part in three different field studies in Wisconsin in 2006, in addition to data from 135 farms in Northern Italy. Data was collected by on-farm visits of researchers, mail-in surveys, or by conversation with dairy managers. Aspects of milking machine and management practices that were studied include: cow numbers, production, vacuum levels, pulsation, milk flow rates, teat condition, and several other measures of parlor performance and efficiency.

Keywords. claw vacuum, milk flow rate, milking machine, milking parlor, parlor efficiency, parlor performance, teat condition

Introduction

We began this paper as a summary of milking parlor performance in Wisconsin with the intention to merge field data from three separate projects being conducted by Drs. Pamela Ruegg and Doug Reinemann. Each project has different objectives but much of the data collected from Wisconsin farms is similar in format. We have added data from Northern Italy because we have had the great fortune of adding a visiting Ph.D. student to our group in 2007 and she has brought to us data of similar farm surveys. We think this data provides an interesting comparison and contrast of dairy systems in Wisconsin and Cenral Europe. These data were collected from over 200 farms in four separate studies, three in Wisconsin and one in Italy from 2003 to present. All of these studies are ongoing with additional data being collected. Further analyses of these data will be presented in future publications.

Note that these are not random samples from the population of farms. In all cases these farms volunteered to allow us to visit their farms and report their data in an anonymous fashion. In addition these farms generally agreed to participate in these surveys because they were motivated to improve the performance of their farms. Thus these farms do not represent average, or even typical operations, but more likely the top tier of farms in Wisconsin and Northern Italy. We thank these farms for allowing us to perform our research there and share our findings with the rest of the world. We hope this data will help milking parlor managers improve the performance of milking parlors by providing real-world benchmarks of milking performance.

Study 1: University of Wisconsin-Extension Milking Parlor User Groups

The UW Extension Parlor User Group project began in 2006 and has been funded by the Extension dairy modernization program. These user groups assemble managers of similar types of milking facilities and meet quarterly to discuss concerns and issues related to milking parlor management and efficiency. Each group consists of from five to ten parlor managers, a county extension agent, a graduate research assistant, and the state milking machine specialist. An initial meeting of users is held to identify the high priority issues or 'study projects'. A student assistant performs a review of research on these topics, visits farms to collect data, or instruct users in data collection protocols. A follow-up meeting is held to discuss results of the literature review and study projects and to define new issues and study projects. A state-wide meeting of all groups to highlight studies from the previous year is also planned.

Field data is analyzed and summarized in individual farm reports and anonymous group average reports that are sent to each farm. These findings are also discussed at subsequent meetings to create discussion and to stimulate development of future projects and areas of interest. Results from 11 farms in two groups are presented here and a general description of the farms is presented in the following table.

General Description of Farm (n = 11)	Mean	Min	Max	Median	Std Dev	Coef. Var.
Number of Cows Milked per day	828	280	2200	600	567	68
Milk Production (Kg/cow/day)	36.5	26.2	44.0	38.0	5.0	13.6

Vacuum and Pulsation

Vacuum recordings and pulsation measurements were done on farms using an electronic vacuum recorder and pulsation analyzer. System vacuum was recorded either at the regulator or in the receiver. Vacuum measurements were taken in the claw during milkings by inserting a long needle through the short milk tube and into the claw (Rasmussen et al, 2003). On farms with milk meters, the milk flow rate was recorded at the time of the claw vacuum measurement during several cow milkings. These data were fitted to a quadratic prediction of average claw vacuum as a function of milk flow rate. Pulsation rate, ratio, and phase lengths were recorded as dry tests by inserting a T-fitting in the short pulse tube.

Vacuum/Pulsation Measures	Mean	Min	Max	Median	Std Dev	Coef. Var.
System vacuum (kPa)	43.9	41.3	45.5	44.4	1.4	3.14
Claw vacuum at low flow, 2kg/min (kPa)	41.1	34.2	43.0	42.0	2.7	6.67
Claw vacuum at high flow, 5kg/min (kPa)	38.5	31.2	41.7	38.6	3.2	8.31
Pulsation rate (ppm) - setting on controller	60	60	60	60	0	0
Pulsation ratio (% A+B phase)	62.1	60.0	66.0	62.0	2.3	3.70
Pulsation B phase (ms)	457	391	498	469	48	10.5
Pulsation D phase (ms)	223	208	244	221	16	7.14

Parlor Performance and Efficiency

Several measures of parlor performance and efficiency were recorded or directly calculated from each farm's parlor management software report. Eight of the 11

farms used three different types of parlor management software. An average value for each farm was calculated by averaging parlor report data for all milking shifts for the day previous our visit (as long as no major abnormalities were reported that day).

Parlor Performance and Efficiency	Mean	Min	Max	Median	Std Dev	Coef. Var.
Average milk flow rate (Kg/min)[1]	2.65	1.95	3.14	2.68	0.37	14.1
Peak milk flow rate (Kg/min)[2]	4.13	3.18	5.05	4.05	0.68	16.5
Total parlor milking rate (kg/hr)	1630	617	3750	1240	1000	61.6
% of time that milking units are attached	33.4	27.0	41.3	33.2	4.9	14.7
Average milking duration (min)	4.7	4.3	6.2	4.5	0.6	12.6
Milk harvest per milking stall (kg/stall/hr)	50.2	30.9	65.5	51.8	10.1	20.1
Number of unit reattachments /1000 milkings	16.3	6.8	29.7	14.7	8.8	54.1
Number of unit falloffs /1000 milkings	30.3	1.4	102	8.9	48.1	159
Number of late re-hangs per /1000 milkings[3]	35.3	3.6	79.2	11.2	37.4	106

Notes: 1. the average milk flow rate is reported as an individual cow's total milk yield divided by the duration of unit attachment for each milking session. There are some differences in the way that the duration is recorded. The two most common methods are; a. the actual time that milk is being recorded in a milk meter, and b. the time from when the 'attach' button is pressed to the time at which the decision to detach is made.
2. The peak milk flow rate is also recorded differently by different systems. Two most common methods are: a. the milk yield in the second minute of milking and b. the maximum milk yield is a specified time – usually one minute, which may or may not occur during the second minute of milking.
3. A late re-hang means that less than 3 lbs of milk was harvested after the unit was reattached.

Teat Condition Scoring

These teat condition scores were done in the months of October and November. The scoring system used is the 4 category system recommended by the Teat Club International (TCI): no ring, smooth ring, rough ring, very rough ring (Mein, 2001). Teat-end scoring was done either during the milking with paper and pencil or by using a special arm attached to a digital camera to photograph one or two teats (rear teat/s in parallel parlors, front-inside teat or rear teat/s in herringbone) and assessing teat-end scores at a later time (Reinemann, 2007). From 50% to 90% of the cows in each pen were scored with the number of teats scored on each farm ranging from 74 to 798, depending of farm/pen size.

TCI recommendations are that if more than 20% of teats score rough or very rough, further investigation should be done to determine the causes of hyperkeratosis. Note that this recommendation is based on the average of a herd. We did not attempt to obtain a herd average, but rather chose specific pens of cows that would be most likely to exhibit changes in teat end hyperkeratosis caused by changes in milking practices. One or two pens were chosen on each farm to represent multiparous cows in mid to late lactation. We would expect hyperkeratosis to be more extreme in these pens than in the herd as a whole.

Teat-end condition Scores	Mean	Min	Max	Median	Std Dev	Coef. Var.
% rough or very rough	45	22	69	49	15	33.2

Study 2: Evaluation of a Modified System of Dairy Farm Regulatory Oversight for Wisconsin Dairy Farms

This project is sponsored by the Wisconsin's Department of Agriculture, Trade and Consumer Protection with the overall objective of evaluating the ability of an alternative method of direct regulatory oversight of high performing dairy farms. Sixteen farms in Wisconsin were enrolled into the study in July 2006. General information was obtained on the first farm visit and farms are then visited monthly to make observations and collect data. Teat-end condition is assessed as described above in study 1. These data represent the period from July to December 2006 and were analyzed with the SAS® means procedure.

General Description of Farms (n=16)	Mean	Min	Max	Median	Std Dev	Coef. Var.
Number of Cows Milked per day	833	200	2350	690	595	71
Milk Production (Kg/cow/day)	39.2	34.2	43.1	45.1	1.91	4.22

Vacuum and Pulsation Measurements

Vacuum recordings and pulsation measurements were done on each farm using the Digimet® vacuum recorder as described in study 1. Findings are below.

Vacuum/pulsation measures	Mean	Min	Max	Median	Std Dev	Coef. Var.
System vacuum (kPa)	45.3	41.9	50.7	45.1	1.91	4.22
Claw vacuum at low flow, 2kg/min (kPa)	42.0	39.1	43.1	42.6	1.38	3.29
Claw vacuum at high flow, 5kg/min (kPa)	40.8	37.4	42.1	41.2	1.51	3.70
Pulsation rate (ppm) – dry test	59.8	58.5	61.9	59.9	0.37	0.62
Pulsation ratio (% A+B phase)	62.1	58.5	69.9	62.2	2.01	3.24
Pulsation B phase (ms)	503.2	430.0	620.0	506.0	37.32	7.41
Pulsation D phase (ms)	264.4	208.0	322.0	271.0	34.51	13.05

Parlor Performance and Efficiency

All of the farms in this study used the Dairy Comp® parlor reports. These data are pooled results from all farms and all milkings on each farm.

Parlor Performance and Efficiency	Mean	Min	Max	Median	Std Dev	Coef. Var.
Milk production (Kg/cow/day)	39.2	34.2	46.8	38.7	3.05	7.7
Average milk flow rate (Kg/min)[1]	2.83	1.30	3.15	2.83	0.14	4.8
Peak milk flow rate (Kg/min)[2]	4.34	2.97	6.35	4.18	1.91	44
Parlor Performance and Efficiency	**Mean**	**Min**	**Max**	**Median**	**Std Dev**	**Coef. Var.**
Total parlor milking rate (kg/hr)	1998	1198	2530	2004	197	9.8
% of time milking units are attached	28.3	16	37	28	2.2	7.9
Average milking duration (min)	4.26	3.50	4.90	4.20	0.24	5.8
Milk harvest per milking stall (kg/stall/hr)	47.6	27.0	57.2	47.7	4.03	8.5
Unit reattachments /1000 milkings	18	0.8	60	14	12	65
Number of unit Falloffs /1000 milkings	9.6	0.0	28	8.8	5.6	58
Late re-hangs per /1000 milkings	11.6	0	86	9.70	9.5	82

Teat Condition Scoring

Teat-end condition is assessed as described above in study 1. These data represent monthly scoring of each farm/pen over the period from July to December 2006.

Teat-end condition Scores	Mean	Min	Max	Median	Std Dev	Coef. Var.
% rough or very rough	34.0	7.8	63.8	35	13.0	38

Study 3: Milk Money Evaluation

Milk Money is a team-based milk quality improvement program designed for Wisconsin dairy producers. The program was developed by Dr. Pamela Ruegg and is supported by University of Wisconsin Extension and the Wisconsin Milk Marketing Board. Dairy producers enroll voluntarily with the goal of improving milk quality. Once enrolled, producers put together a team that consists of various industry professionals including veterinarians, University of Wisconsin Extension agents, milking equipment representatives, milk plant field representatives, and others. These teams meet four times, usually in one month intervals, to develop goals and assign tasks to team members to help reach those goals. Previous research has been done analyzing the short-term (meetings one through four) impact of Milk Money on these dairies (Rodrigues, et al, 2005). A study is currently underway investigating the "Long Term Performance of Herds Completing Milk Money Programs." To date, 56 Wisconsin dairy farms that had previously enrolled in Milk Money have enrolled for a one-time farm visit. These farms were visited for one to three hours during milking time from July to September, 2006.

The following data was collected; milking time analysis using a stopwatch, milk flow, and timing data using a Lactocorder®, teat end vacuum measurements, teat condition, and other general farm observations (some published elsewhere).

General Farm Description (n = 54)	Mean	Min	Max	Median	Std Dev	Coef. Var.
Number of cows milked per day	323	35	1250	260	301	93
Average milking duration (min)	5.9	3.3	11.7	5.6	1.5	26
Maximum milking time (min)	8.6	4.2	19.0	8.1	3.2	37
Minimum milking time (min)	4.1	1.8	11.5	3.8	1.5	36

Vacuum and Lactocorder® Measurements (n = 56)	Mean	Min	Max	Median	Std Dev	Coef. Var.
System vacuum (kPa)	45.7	37.3	50.9	45.6	3.5	7.6
Average Claw vacuum (kPa)	37.7	27.8	44.1	38.6	2.7	7.2
# of prep-lag times recorded/farm	9.1	4	18.0	8.0	3.1	34
# of short prep-lag times (<60 sec. stimulation to attach)	1.9	0	14.0	0.0	3.6	195
# of long prep-lag times (>150 sec. stimulation to attach)	1.0	0	8.0	0.0	1.6	162
# of Lactocorder® curves per farm	6.2	2.0	14.0	6.0	2.1	34
# of bimodal milk-flow curves observed per farm	1.1	0.0	3.0	1.0	1.0	96

At least 1 bimodal milk flow curve		Mean	%
	yes	36	64
	no	20	36
Presence of Short prep-lag time on farm (at least 1 prep-lag time <60 sec)		**Mean**	**%**
	yes	21	38
	no	35	62
Presence of Long prep-lag time on farm (at least 1 time prep lag >150 seconds)		**Mean**	**%**
	yes	23	41
	no	33	59

Teat-end Condition

These teat condition scores were done from July to September, 2006. Teat end condition scoring was performed by scoring all four teats of each cow using the 4 category scale recommended by the TCI. Teats were scored by visual observation using a flashlight. In general, on farms with high herd sizes, teats were scored on the high producing mature cow groups and on farms with low herd sizes, teats were scored on all cows. Note that these scores are more representative of herd averages and thus cannot be directly compared to studies 1 and 2 cited above. These data are presented below.

Teat-end Condition	Mean	Min	Max	Median	Std Dev	Coef Var
Teat-end condition % rough or very rough	23.7	1.0	63	23	12.2	51
Number of teat-end scores per farm	144	53	57	280	129	37

Study 4: Italian Study

Two different projects are presented here and both were performed on Northern Italian dairy farms between 2003 and 2006. The aim of these projects was to define the optimal procedures and critical control points for milking high producing dairy cows and to understand the complex and interactive relationships of milking routine, milking equipment, and stage of lactation on milk yield, milk flow rate, and teat condition, udder health, and milk quality. A summary of applicable areas of interests to this paper of the herds in both projects is presented in the tables below.

General Description of Farms (n = 135)	Mean	Min	Max	Median	Std Dev	Coef. Var.
Number of cows per herd	144	27.0	600	120	98.9	69
Milk production (Kg/cow/day)	28.1	18.6	36.7	28.4	3.7	13

Milking Characteristics

Milk flow is influenced by the dynamics of oxytocin production and release, the percent of udder fill, and the relative percentages of cistern and alveolar milk. The complete removal of alveolar milk at each milking is a prerequisite to maintain milk synthesis and secretion on a high level throughout lactation (Bruckmaier, 2005). The study of milk flow during milking can give useful information to ensure optimal milk ejection and removal without over-milking.

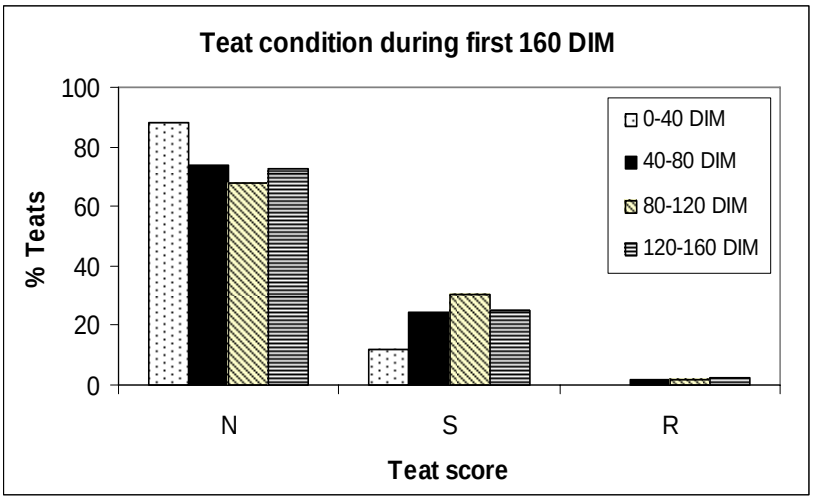
In the first project, 3089 individual milk flow profiles of Italian Friesian cattle were made on about 34% of the cows on 135 farms. Flow profiles were measured using an electronic mobile milk flow meter (Lactocorder, WMB) which measures milk flow, milk yield, and milk electrical conductivity during milking. It provides information about time of milk flow incline phase, plateau phase, decline phase, over-milking phase and stripping phase. Incline phase is the length of time at the start of milking from >.5Kg/min of flow to start of plateau phase. Decline is period of milk flow from end of plateau phase to flow rate <.5Kg/min. Findings are below.

Milking Characteristics (n=135)	Mean	Min	Max	Median	Std Dev	Coef. of Var.
Total milk yield/milking (Kg)	13.8	0.1	44.2	13.8	4.62	33
Milk yield in the first 2 min	5.75	0.19	18.13	5.61	2.17	38
Milk yield in the first 3 min	8.74	0.29	27.73	8.64	2.94	34
Machine-on time (min)	6.87	0.47	18.67	6.49	2.41	35
Average milk flow (kg/min)	2.39	0.30	8.45	2.37	0.73	31
Maximum milk flow (kg/min)	3.76	0.23	9.80	3.63	1.23	33
Bimodality (%)	35.6	0	1	0	47.9	135
Time of incline phase (min)	0.89	0.05	9.52	0.84	0.48	54
Time of plateau phase (min)	2.25	0.05	12.37	1.91	1.67	74
Time of decline phase (min)	2.70	0.05	15.4	2.52	1.40	52
Time of over-milking phase (min)	0.79	0.05	12.69	0.47	1.09	138
Time of machine stripping (min)	1.08	0.14	7.33	0.89	0.86	80
Milk yield during stripping (kg)	0.60	0	6.05	0.39	0.71	118
Peak milk conductivity (ms/cm)	6.47	4.61	9.96	6.38	0.69	11

An interesting difference between these Italian farms and the Wisconsin sample is the difference in average and peak flow rates. This difference may be partially explained by the likelihood of lower claw vacuum levels and less aggressive detacher settings in Italian than in Wisconsin herds. Also, all the Italian herds were milked twice daily while over two-thirds of the Wisconsin farms will milked three times daily. Herds milked twice daily tend to have lower milk flow rates.

Teat Condition Scores

In the second project, teat condition scores using a four point scale described by Mein et al (2001) were collected monthly from 80 first-lactation cows from six farms. Teat condition scores during the first 160 DIM were mostly no ring (N) and smooth (S) (98.5%). Teat condition gets slightly worse between 80-120 DIM. No very rough (VR) teat scores were recorded during the first 160 DIM. Findings are below.



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