Survey of Milking Facilities, Management, and Performance on Wisconsin and Italian Dairy Farms

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Abstract. Dairy facilities designers and dairy managers require feedback from operating facilities in order to improve the facility design and management process. The objective of these studies is to provide such feedback by documenting the relationship between dairy facilities and management practices on milking parlor efficiency, milk quality, teat condition, and udder hygiene. 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. Descriptive statistics of milking machine performance have been presented earlier. This paper presents additional data regarding dairy facilities and milking parlor labor efficiency including: milking parlor type and size, number of operators, milking routines, cows/hour milked, annualized cost estimates of milking center and labor, milk quality measures, udder hygiene, bedding material, teat condition, milk flow rates, and milking vacuum levels.

Keywords. claw vacuum, milk flow rate, milking parlor, milk quality, 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 some 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 that this data provides and interesting comparison and contrast of dairy systems in Wisconsin and central 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. Descriptive statistics of milking machine performance have been presented earlier by Bade et al. (2007). This paper presents additional data regarding dairy facilities and milking parlor labor efficiency.

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 extend our sincerest appreciation to these farms for allowing us to visit and observe them and to share their data with the

rest of the world. We hope that this data will help milking parlor managers improve the performance of milking parlors by providing some 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 to meet on a quarterly basis 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. Each meeting is about two hours in duration and the groups are organized regionally to minimize travel time. A state-wide meeting of all groups to highlight interesting 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 research projects or interest areas of the group. This section presents group reports from 11 farms in two user groups.

General Description of Farms and Milking Parlors

These data were acquired through observation, interviews with parlor managers, and reports from the farm's milk plants. The bacteria count and Somatic Cell Count (SCC) data are presented as Log_{10} values and geometric means. Not all farms reported all counts and not all counts were done on each shipment of milk. On most farms we received reports for the previous month of shipments before our first farm visits, but several farms may not have had all of this information available, so shorter time periods are reported here.

(n = 11)	Mean	Min	Max	Median	Std. Dev. (SD)	Coef. Var. (CV)
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	14
Parlor size (number of milking units)	30	16	88	24	21	69
Number of cows per milking unit	27	14	45	25	8	30
Number of parlor operators	2.0	1	4	2	0.8	39
Number of milking units per operator	14.5	8.0	22.0	12.0	4.7	32

Milking frequency	Herds
2 per day	1
3 per day	9
3 x some pens 4x	1

Milking Parlor Stall Type	Farms
Parallel parlor	10
Herringbone parlor	1

Milk quality measures (log_{10})	Mean	Min	Max	Median	SD	CV
Somatic Cell Count /ml	5.34	4.95	5.75	5.37	0.15	2.9
Standard Plate Count (or PLC) (cfu/ml)	3.37	0.00	5.36	3.48	1.10	33
Coliform Count (cfu/ml)	2.05	0.00	3.18	2.08	0.76	37
Lab Pasteurized [Thermoduric] Count (cfu/ml)	1.74	0.00	2.68	1.79	0.65	38
Preliminary Incubation Count (cfu/ml)	5.32	4.87	6.00	5.15	0.51	9.6

Vacuum and Pulsation

Vacuum recordings and pulsation measurements were done on each farm 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	SD	CV
System vacuum (kPa)	43.9	41.3	45.5	44.4	1.4	3.1
Claw vacuum at low flow, 2kg/min (kPa)	41.1	34.2	43.0	42.0	2.7	6.7
Claw vacuum at high flow, 5kg/min (kPa)	38.5	31.2	41.7	38.6	3.2	8.3
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	3.7
Pulsation B phase (ms)	457	391	498	469	48	11
Pulsation D phase (ms)	223	208	244	221	16	7.1

Milking Parlor Time Studies

Parlor time studies are observations and timings of parlor worker movements and milking routines as described by Reinemann et al (2006). All of the following data was recorded by observation of the milking routine except for the average duration, which was reported by the parlor management software on those farms that were equipped with milk meters (8 of 11). Several measures of each routine were recorded to account for variation. Prep/attach time is the average time it takes to prep a cow and attach the milking unit. The timer starts when an individual worker starts prepping the first in a series of cows and stops when he/she finishes attachment/adjustment of the last unit in the series that he/she is responsible for. This total time is then divided by the number of cows/units in the series. Post-dip time is the average time it takes to apply post-dip to all four teats and move to the next cow. Cow movement is a recording of the average seconds per cow that it takes to release one group of cows and reload one side of the parlor. Timing starts when the exit gate is opened to allow milked cows to leave the stalls. The timing stops when the first worker starts prepping the first cow of the next group. This total time is then divided by the number of cows/stalls that were loaded on the side.

Parlor Time Studies	Mean	Min	Max	Median	SD	CV
Prep/attach time (sec/cow)	30.6	22.9	40.2	30.8	5.6	18
Post dip time (sec/cow)	3.9	3.0	5.0	4.0	0.8	21
Cow movement time (sec/cow)	5.6	1.8	11.0	5.3	2.9	52
Farm Ave. milking duration (min)	4.7	4.3	6.2	4.5	0.6	13

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 to our visit (as long as no major abnormalities were reported that day).

	Mean	Min	Max	Median	SD	CV
Milk production (Kg/cow/day)	36.5	26.2	44.0	38.0	5.0	14
Farm Ave. milk flow rate (Kg/min)[1]	2.65	1.95	3.14	2.68	0.37	14
Farm Ave. Peak milk flow rate (Kg/min)[2]	4.13	3.18	5.05	4.05	0.68	17
Total parlor milking rate (kg/hr)	1630	617	3750	1240	1000	62
Milk harvest per worker (kg/person/hr)	710	479	1050	622	205	29
Total parlor throughput (Cows/hour)	134	52	340	100	93.9	70
Worker productivity (Cows/person/hr)	57.7	36.0	85.0	52.0	19.2	33
% of time that milking units are attached	33.4	27.0	41.3	33.2	4.9	15
Average milking duration (min)	4.7	4.3	6.2	4.5	0.6	13
Milk harvest per stall (kg/stall/hr)	50.2	30.9	65.5	51.8	10.1	20
Stall productivity (Milkings/stall/hr)	4.0	2.8	4.5	4.1	0.5	13
Unit reattachments /1000 milkings	16.3	6.8	29.7	14.7	8.8	54
Unit falloffs /1000 milkings	30.3	1.4	102	8.9	48.1	160
Late re-hangs per /1000 milkings3	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. The 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.

The following milking parlor efficiencies were estimated using the UW Extension Parlor Planning software package (Reinemann et. al, 2006). These estimates were made using individual farm time studies, data from individual farm parlor management software reports, and industry average cost of milking facilities and wages paid to farm labor.

Monetary Efficiency Estimates	Mean	Min	Max	Median	SD	CV
Milking center + labor/cwt of milk ($)	1.30	0.90	1.85	1.27	0.32	24
Labor cost (cents per cow milked)	21.4	13.1	31.9	21.5	7.25	33

Teat Condition Scoring

These teat condition scores were done in the months of October and November. The system used for scoring the teats 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 condition was recorded on as many teats as possible in each pen of cows, either with paper and pencil form at milking time 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 on 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	Mean	Min	Max	Median	SD	CV
% rough or very rough	45	22	69	49	15	33

Bedding Material and Management

The type of bedding material and stall management used on the User Group farms (all used free-stalls) is reported below. Data was collected by interviewing parlor managers from each farm and represents each farm on the visit day. Six farms used sand bedding, two farms used manure solids from anaerobic digesters as bedding, and two farms used wood shavings as bedding. Frequency of adding fresh bedding to the stalls was recorded. Two farms bedded some pens once/week and other pens twice/week. These farms were recorded as having a bedding frequency of "1.5 times/week." The frequency of manual stall grooming was also recorded as the number of times per day that stalls were manually leveled and/or manually removed of manure. The frequency of mechanical stall grooming (stirring/leveling bedding) was also recorded.

Bedding management	Mean	Min	Max	Median	SD	CV
fresh bedding / week	1.8	1.0	3.5	1.5	0.9	48
Manual grooming / day	2.9	2.0	3.0	3.0	0.4	12
Mechanical grooming /week	3.0	1.0	7.0	2.0	2.8	94

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. All farms ship their milk to the same milk plant. This plant is performing the same milk quality tests on each milk shipment. General information was obtained on the first farm visit. Farms are then visited monthly to make observations and collect data. Somatic cell and bacterial counts from each milk shipment are obtained electronically from the milk plant's website. 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	Mean	Min	Max	Median	SD	CV
Number of cows milked per day	833	200	2350	690	595	71
Farm Ave. Milk (Kg/cow/day)	39.2	34.2	43.1	45.1	1.91	4.2
Parlor size (number of milking units)	32	10	88	26.0	21.1	65

Number of cows per milking unit	47.8	20.0	71.9	43.1	15.7	33
Number of parlor operators	2.4	2	5	2.0	0.9	36
Number of milking units per operator	14.2	6.0	22	14	5.0	35

Milking frequency/day	Herds	Milking Parlor Stall Type	Farms
2x	1	Parallel parlor	10
3x	15	Herringbone parlor	5
		Rotary Parlor	1

Milk quality measures (log_{10})	Mean	Min	Max	Median	SD	CV
Farm Ave. Log10(SCC/ml)	5.30	4.77	5.79	5.31	0.14	2.7
Farm Ave. Log10(SPC/ml)	3.16	0.00	6.30	3.47	1.46	46
Farm Ave Log10(Coli/ml)	1.78	0.00	3.18	1.78	0.89	50
Farm Ave Log10(LPC/ml)	1.95	0.00	3.94	2.11	0.76	39

Vacuum and Pulsation Measurements

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

Vacuum/pulsation measures	Mean	Min	Max	Median	SD	CV
System vacuum (kPa)	45.3	41.9	50.7	45.1	1.91	4.2
Claw vacuum at 2kg/min (kPa)	42.0	39.1	43.1	42.6	1.38	3.3
Claw vacuum at 5kg/min (kPa)	40.8	37.4	42.1	41.2	1.51	3.7
Pulsation rate (ppm) dry test	59.8	58.5	61.9	59.9	0.37	0.6
Pulsation ratio (% A+B phase)	62.1	58.5	69.9	62.2	2.01	3.2
Pulsation B phase (ms)	503.2	430.0	620.0	506.0	37.32	7.4
Pulsation D phase (ms)	264.4	208.0	322.0	271.0	34.51	13

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.

	Mean	Min	Max	Median	SD	CV
Farm Ave. production (kg/cow/day)	39.2	34.2	46.8	38.7	3.05	7.7
Farm Ave. Milk Harvest (Kg/min)[1]	2.83	1.30	3.15	2.83	0.14	4.8
Farm Ave. Peak milk (Kg/min)[2]	4.34	2.97	6.35	4.18	1.91	44
Total parlor milking rate (kg/hr)	1998	1198	2530	2004	197	9.8
Milk harvest (kg/person/hr)	999	599	1265	1002	98	9.8
Total parlor throughput (Cows/hour)	169	110	204	168	15.9	9.4
Worker productivity (Cows/person/hr)	84.6	55.0	102	84.0	7.9	9.4
% of time milking units are attached	28.3	16	37	28	2.2	7.9
Farm Ave. milking duration (min)	4.26	3.50	4.90	4.20	0.24	5.8
Milk harvest (kg/stall/hr)	47.6	27.0	57.2	47.7	4.03	8.5
Stall productivity (Milkings/stall/hr)	4.0	2.5	4.6	4.0	0.27	6.9
Unit reattachments /1000 milkings	18	0.8	60	14	12	65
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	Mean	Min	Max	Median	SD	CV
% rough or very rough	34.0	7.8	63.8	35	13.0	38

Bedding Material and Management

The type of bedding material and free-stall management used on study farms (all used free-stalls) is reported below. Udder hygiene was scored on these farms once per month. The system used for scoring udder hygiene is also a 4-point system in which 1 = free of dirt, 2 = slightly dirty, 3 = moderately covered with dirt, and 4 = completely covered with dirt (Ruegg, 2002). One study reported that cows with udder hygiene scores of 3 and 4 were 1.5 times more likely to have major pathogens isolated from milk samples compared with cows with hygiene scores of 1 and 2 (Schreiner and Ruegg, 2003).

Eleven farms use sand bedding, three farms used manure solids from anaerobic digesters as bedding, and two farms use wood shavings as bedding. When the study began, five farms were using manure solids bedding and switched to sand during the study. Fifteen farms removed manure from free-stall barns using alley scrapers or mobile scrapers and one farm used a flush system.

Barns/bedding	Mean	Min	Max	Median	SD	CV
Udder Hygiene Score (% R and VR)	64.4	22	98	65	11.8	18
Add fresh bedding / week	2.3	0.5	7	1.5	2.15	94
Manual grooming / day	2.1	0	3	3	1.29	61

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 consist 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, teat cleanliness, udder hygiene scores using a four-point scale, bulk tank samples plated on Petrifilm™ products (Staph Express, Coliform, and Aerobic count plates), and general farm observations (i.e. stall and bedding type used for lactating cows). Bulk tank milk samples (n = 2 or 3 samples per farm) were collected and frozen by farm personnel prior to the farm visit. The samples were thawed, commingled, and 1ml of milk was plated on each of the Petrifilm™ plates. Note the Max and Min for these milking data are by cow and not by farm average as for the first two studies reported.

General Description (n = 54)	Mean	Min	Max	Median	SD	CV
Number of cows milked per day	323	35	1250	260	301	93
Observation time (minutes)	113.8	60.0	180	115.0	25.4	22
Number of workers	1.7	1.0	3.0	2.0	0.5	29
Number of milking units	16	3	44	16	10.3	64
Cow Ave. milking duration (min)	5.9	3.3	11.7	5.6	1.5	26
Maximum cow milking time (min)	8.6	4.2	19.0	8.1	3.2	37
Minimum cow milking time (min)	4.1	1.8	11.5	3.8	1.5	36

Milking frequency (n = 54)	N	%
2x	27	50
3x	26	48
4x	1	2
Milking Facility type (n = 56)	**N**	**%**
Flat Barn	3	5
Herringbone or Parallel milking Parlor	39	70
Rotary milking Parlor	1	2
Tie-stall or stanchion Barn	13	23
Stall and bedding type (n = 54)	**N**	**%**
Free-stall	41	76
Stanchion-stall	3	6
Tie-stall	10	18
Sand	21	39
Sawdust	16	30
Straw	10	19
Other	7	13

Milk quality measures (log_{10})	Mean	Min	Max	Median	SD	CV
Staph. au. /ml	1.28	0.00	3.43	1.24	0.76	59.3
Coli/ml	1.72	0.30	4.00	1.65	0.80	46.2
Aerobic/ml	2.71	1.43	4.00	2.66	0.58	21.2

Milking Vacuum and Lactocorder® Measurements

(n = 56)	Mean	Min	Max	Median	SD	CV
System vacuum (kPa)	45.7	37.3	50.9	45.6	3.5	7.6
Cow Ave. 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 /farm	6.2	2.0	14.0	6.0	2.1	34
# of bimodal milk-flow curves / 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
Short prep-lag time (at least 1 prep-lag time <60 sec)	**Mean**	**%**
Yes	21	38
No	35	62
Long prep-lag time (at least 1 time prep lag >150 seconds)	**Mean**	**%**
Yes	23	41
No	33	59

Teat-end Condition, Teat and Udder Hygiene Scores, and Milking Routines

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 large herd sizes, teats were scored on the high producing mature cow groups and on farms with small 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. Teat cleanliness scoring was performed by wiping each teat of each cow with a gauze pad soaked in alcohol after the milking technicians prepared the cows for milking before milking unit attachment. The gauze pads were scored according to the amount of dirt or manure present and these values were recorded on a four point scaled score sheet ranging from score 1, indicating no dirt or manure present, to score 4 indicating a heavy soiling of the gauze pad. These data are presented below.

	Mean	Min	Max	Median	SD	CV
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
Udder Hygiene Score (% 3 and 4)	21.9	2	61	20	13.8	63
udders scored for UHS/farm	96.1	33	188	96	35.1	37

Poor teat condition (>20% of scores R+VR)	N	%
Yes	36	64
No	20	36
Poor UHS (>20% 3 and 4)	**N**	**%**
Yes	29	52
No	27	48

Complete milking routine (strip, dip, dry, postdip)	N	%
yes	52	93
no	4	7
Use gloves during milking (n = 56)	**N**	**%**
yes	54	96
No	2	4

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, teat condition, udder health, and milk quality. A summary of the herds in both projects is presented in the table below. A striking difference between these Italian farms and the Wisconsin sample is that all of the Italian herds are milked twice per day regardless of the type of milking facility whereas almost all of the farms in Wisconsin, who had milking parlors, milked three times per day and those milking in tie-stall barns milked twice per day. Cows milked two times per day tend to have lower milk flow rates in comparison to cows milk three times per day. This fact, along with the likelihood of lower claw vacuum and less aggressive detacher settings on Italian farms may help to explain the lower average and peak milk flow rates observed in these Italian herds versus the Wisconsin herds.

General Description of Farms and Milking Parlors

(n = 135)	Mean	Min	Max	Median	SD	CV
Number of cows per herd	144	27.0	600	120	98.9	69
Farm ave. production (Kg/cow/day)	28.1	18.6	36.7	28.4	3.7	13
DIM	242	1	715	233	139	57
Number of milking units	17.5	3	50	16	9.7	55
Number of parlor operators	1.5	1	3	1	0.6	40
Number of milking units per operator	12.0	2.0	28.0	10.8	6.3	52
Number of cows per milking unit	8.3	3.0	16.0	7.8	2.58	31

Parlor types (n=135 farms)	(%)
Herringbone parlor	59
Parallel parlor	23
Auto-tandem parlor	8
Rotary parlor	5
Pipeline in tie stall barn	6

Milk Quality Measures (n = 135)	Mean	Min	Max	Median	SD	CV
Fat (%)	3.79	1.50	7.74	3.75	0.79	21
Protein (%)	3.35	1.30	4.80	3.32	0.39	12
Log_{10} SCC	5.07	3.30	7.05	5.00	0.59	12

Milking Characteristics

In the first project of the Italian study, milk flow curves of Italian Friesian cattle were made on 135 farms. Each farm was visited once during milking operation time. On each farm about 34% of cows were measured. A total of 3089 individual milk flow profiles were measured with an electronic mobile milk flow meter (Lactocorder, WMB). The Lactocorder 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. Data was also collected on each farm about pre-stimulation routine, pre and post-dipping, type of parlour, parlour size and number of operators. Milk production and SCC were obtained from the database of AIA (Italian Breeders Association) and correspond to the results of the test day nearest to the date of the milk flow monitoring. Findings are

presented below. Note the Max and Min for these milking data are by cow and not by farm average as for the first two studies reported.

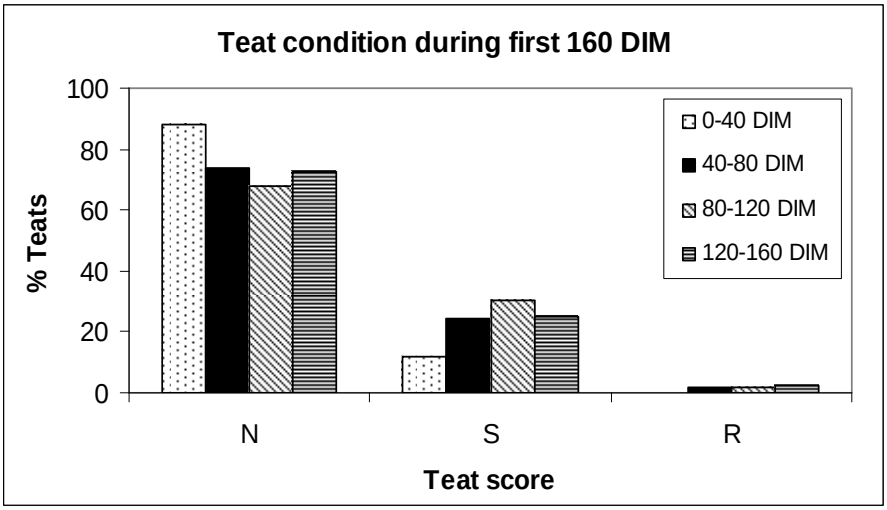
	Mean	Min	Max	Median	SD	CV
Total milk yield/milking (Kg)	13.8	0.1	44.2	13.8	4.62	33
Milk yield in the first 2 min	5.75	0.19	18.13	5.61	2.17	38
Milk yield in the first 3 min	8.74	0.29	27.73	8.64	2.94	34
Machine-on time (min)	6.87	0.47	18.67	6.49	2.41	35
Ave. milk harvest (kg/min)	2.39	0.30	8.45	2.37	0.73	31
Peak milk (kg/min)	3.76	0.23	9.80	3.63	1.23	33
Bimodality (%)	35.6	0	100	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

In the first Italian project, the number of cows/herd averaged 144 with a standard deviation of 98.9 cows and the number of cows/unit was lower than the reported numbers in Wisconsin study 1 (8.3 vs. 14), but was comparable to Wisconsin studies 2 and 3 (8.3 vs. 7.1 and 8.3 vs. 9.4 respectively). Mean milk yield/day was lower than in Wisconsin studies 1 and 2 (28.1 vs. 36.5 and 28.1 vs. 39.2).

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 a lactation (Bruckmaier, 2005). The study of milk flow during milking can give useful information to ensure optimal milk ejection and removal without over-milking. The study results presented here show that 63% of the total milk yield is harvested during the first 3 minutes of milking. Machine on-time was 6.9±2.41min. The time of incline phase, the period of time between milk flow>0.5 kg/min and the start of plateau phase, was 0.9±0.48min. The time of decline phase, period from the end of plateau to milk flow<0.5 kg/min, was quite long (2.7±1.4min). Over-milking phase was 0.6 ± 0.72 min (11.6 % of total milking time). Also, the percentage of bimodal curves was recorded in 35.6% of the milk flow rate curves that we recorded. Average and maximum milk flow rates were 2.4 ± 0.73 and 3.8 ± 1.23 respectively.

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 different 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 presented in the following graph.



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