The value of health data from dairy farmers in the United States

J.S. Clay[1], K.L. Parker Gaddis[2] and C. Maltecca[2]

[1]*Dairy Records Management Systems, Raleigh, NC 27603, USA*
[2]*Department of Animal Science, College of Agriculture and Life Sciences North Carolina State University, Raleigh, NC 27695-7621,USA*

Abstract

In the United States, most dairy farmers who use on-farm dairy management systems voluntarily record health incidences to facilitate effective cattle management. However, there is no national effort to organize or regulate the recording of health data such as enforcing standard or consistent definitions of health conditions. But when the data have been aggregated into experimental databases, several researchers have been able to compute lactation incidence rates, heritabilities and reliabilities at levels that are relatively comparable with other studies. PCDART from DRMS is one of three primary on-farm software systems that service dairy farmers and provide typical methods for data recording such as flexible health definitions, unlimited number of events and assistance with consistent within farm recording. There are 3250 herds (845K cows) that are managed by producers using PCDART and also enrolled on DHIA. Herds are representative of U.S. herd sizes and breeds. Of these herds, 44% deliver health incidences for off-farm backup at DRMS. Another 45% of herds also record health incidences at a lower rate, but these herds do not routinely deliver data files for off-farm backup at DRMS. Data recording histories for 'backup' herds were assessed for calving years 2009 through 2011 for entry of 34 recognized mature cow conditions of varying value to the dairy industry. Lactation incidence rates were similar to those found in earlier studies under more controlled environments. Additionally, the rates of entry of health events for large 'non-backup' herds were comparable to those of large 'backup' herds. 'Backup' herds recorded a mean of 123 events per 100 cows per year and 65% of herds recorded a minimum of 10 usable events per 100 cows per year. Larger herds (number of cows>500) recorded useful data at almost twice the rate of smaller herds. The most prevalent conditions were mastitis, lameness, metritis, cystic ovaries, other reproductive problems, retained placenta, Johne's and ketosis. There is sufficient potential in both volume and quality of U.S. health data to contribute to computation of meaningful genetic measures for selection using conditions of concern to producers.

Keywords: health events, farmer input, on-farm.

Introduction

Efforts in the United States to coordinate the collection of health event data from dairy farmers have not been successful for two primary reasons: lack of a mandated and structured system and expected vulnerability of information from private dairy farms when data are placed under the control of governmental agencies. However in the U.S., most dairy herd managers rely on one of just a few different on-farm dairy herd management software systems to record dairy cattle health events in a within-herd structured manner. The incentives for farmers to record health incidences are rooted in their desire to quantify incidence rates, manage treatments and minimize financial losses resulting from impacts of disease and threats of contaminated milk or meat. This presentation will describe the breadth, depth and current availability of health events from U.S. dairy producers to be used in a national Genetic Evaluation Program.

Dairy Records Management Systems (DRMS) is one of four dairy records processing centers in the United States and, as of January 1, 2013, DRMS centrally processed DHIA records for 13,432 herds with 2,109,684 cows, 48.7% of the cows enrolled on DHIA. Currently, 3,250 herds use the DRMS' PCDART on-farm dairy herd management software. Cows in these herds represent approximately 40% of the cows serviced by DRMS.

In PCDART, dairy farmers may assign their own 4-character mnemonic codes and 12-character description that fits their management schema of disease management. Although this allows personal customization and a wide range of terms to describe identical diseases, it also makes it difficult when using these data for genetic assessment. Attempts to standardize within the U.S. dairy industry have proven futile but recent research at North Carolina State University (Parker Gaddis, *et al.*, 2012) has affirmed that these data as currently reported can be used effectively to predict genetic value of breeding animals.

This presentation will address the current potential and availability of health events from on-farm dairy herd management systems, numbers of herds, the rates of reporting and the resulting volume of data that might be available to contribute to a U.S. national evaluation of dairy health events.

Data evaluated

Data included lactation records and health events from herds that were enrolled on PCDART for a minimum of two calendar years during the period of January 1, 2009 and December 31, 2012. Corresponding lactation records were edited to include those initiated during January 1, 2009 through December 31, 2011 for cows in parities one through five with complete and valid animal identification and cows not terminated during the lactation. There were 549,393 cows with 841,604 lactations in 1423 herds. Breed distribution was 89.8% Holstein, 5.8% Jersey, 3.1% crossbred and 1.2% others.

Geographically, there were herds in 42 of the 48 continental states with a fairly even distribution in most regions except for a lower concentration in the western dairy states of California and Washington.

Table 1 characterizes several herd metrics by herd size. On average, smaller herds produced less milk, produced milk with slightly lower quality, had lower reproductive performance, had a greater rate of herd turnover, experienced cows dying at a higher rate and used lower quality service sires as measured by Net Merit.

Health event data were standardized using 4-character mnemonic codes and 12-character descriptions as defined by each dairy farmer and were corrected for inconsistency and improper spelling. Table 2 lists example 4-character mnemonic codes and illustrates the variety of classification across herds. Health events totaling 4,659,600 from the four-year period were edited to include only events from adults within parities one through five and recorded within 365 d of calving. Data were further edited to include only events from one of 34 targeted categories yielding 2,029,263 health events. This included additional edits to eliminate events of dystocia and retained placenta greater than 7 days within calving.

Table 1. Average herd characteristics by herd size.

Size (# cows)	# Herds	R.A.* Cows	R.A. Milk	R.A. Fat	R.A. Prot	Daily Milk	SCC	Days to 1st serv	Actual calv intv	Preg rate	R.A. Left (%)	R.A. Died (%)	Serv Sire NM$
< 100	308	76	9,224	289	637	32	2.6	88	14.0	17	43	6.4	344
100 - 499	864	227	10,280	318	702	35	2.5	82	13.6	19	40	6.2	387
500 - 999	173	689	10,816	338	744	37	2.4	79	13.4	20	41	6.8	408
> 1000	78	1954	10,594	329	725	36	2.3	77	13.2	20	38	5.8	393
Total/Avg	1423	346	10,134	315	694	34	2.5	83	13.7	18	41	6.3	381

* R.A. = rolling average

To be included, herd-years were required to have a minimum of at least one reported incidence of the targeted health event and a minimum of 5 cows. To eliminate excessive reporting levels, herd-years were excluded when the reporting frequency exceeded 2 standard deviations above the mean reporting frequency for that health event.

Records were excluded when the herd was not enrolled on PCDART for two complete calendar years. Although such a restriction may not necessarily be relevant, it afforded expeditious data assessment but more importantly it eliminated initial partial years when dairy producers were learning the system and final partial years when dairy farmer attention may be waning.

Seventy-nine percent of the herds (n=1094) contributed data for the entire four years; 8 percent (117 herds) contributed data for three years and 13 percent (179 herds) contributed data for two years. The average annual turnover of herds on PCDART for the past five years has been 12% enrolling herds and 8% withdrawing herds so

Table 2. Examples of mnemonics used to denote health events.

Health event and associated mnemonics
CYST=cystic ovary: 2CYS,3BRD,CFLO,CFRO,CLO,CLO1,CLO2,CRO,CSTO,CSTR,CY L, CY R,CY-L,CY-R,CYL,CYR,CTLN,CYBO,CYEX,CYLO,CYLR,CYRO,CYRT,CYS,CYSL, CYSR,CYST,CYVE,FCLU,LCST,LCY,LCYS,LOCY,OPCS,OVCO,OVCY,PO3X,POLY, RCY,RCYS,ROCY,STAT,CYST,CIST
KETO=ketosis: ACET,ACID,ACIT,ACTI,FEKE,IV,KE,KET,KET1,KET2,KET3,KETD,KETH, KETO,KITO, KTOS,NVKT,KETO,KET5,KET.,KETS,KET+
LAME=lameness: BDFT,BLCK,BLK,BLKF,BLOC,BLOK,F-RT,FEET,FINJ,FOOT,FROT, FTAB,FTLG,FTR,FTRT,HOBB,HOCK,HOOF,HROT,LAME,LEG,LEGS,ROT,WRAP,LAME, LIMP,LAMN
MAST=mastitis: EMAS,FREM,M +2,M +3,M 4Q,M GG,M HF,M LF,M LR,M RF,MRR,M.F., M-?,M+,M-1,M-2,M-3,M-4,M4QT,MAS,MAS4,MASR,MAST,MBAG,MLF,M-F,MLFQ,MLR, M-LR,MLRQ,MMQ,MRF,M-RF,MRFQ,MRR,M-RR,MRRQ,M-E,MST1,MST2,MST3,MSTA, MT,MT2+,MTRE,Q.MA,QMSR,QTMS,QTMT,QUAR,QUTR,STAP,STAR,STPH,STPQ, STRP,TOX,TOXI,TOXM,TX,TXCQ,TXIC,MYCO,DUMP,MAS1,MLFQ,MBRQ,MBLQ, MA2+,MFRQ,MAST
METR=metritis: ECP,MET,METR,MTRI,PUS,PUSS,PYMO,PYO,PYOM,UTME,METR, ENDO,MET1,MET+
RETP=retained placenta: RETP,NCLN,R.P.,REPT,RETA,RETP,RFM,RFS,RMAB,RP,RPIN, RPL,RPRE,RTFM,RTPL,UTRP

the current effective availability of data will probably persist or increase. As new dairy farmers become accustomed to the system and how to capitalize on the opportunities of recording health events they will probably add increasing numbers of health events.

Health events were initially chosen for inclusion based on prevalence in the database. It is acknowledged that it will be important to apply additional criteria when deciding whether a health event should be targeted for genetic evaluation. Kelton, *et al*. (1998) advised that diseases must meet "most, if not all, of the following criteria":

1. the disease was currently recorded and reported;
2. the median reported frequency of occurrence of the disease in adult dairy cows was 5% or greater;

3. the disease had a documented economic significance; and
4. the disease manifested itself clinically such that a discrete case definition, which could be used by a producer or veterinarian without the need for laboratory confirmation, could be established.

The rate of occurrence of the edited health events was 37.4% in first lactation cows, 28.2% in second lactation, 19.6% in third lactation, 10.2% in fourth lactation and 4.6% in fifth lactation. After assessing the rate of occurrence for the targeted 34 traits, nine health events were eliminated because of each of them were represented in less than 20 herds. These events included adhesion, cancer / tumor, bloat, coliform mastitis, E. coli, foot ulcer, stillbirth / mummy fetus, uterine infection / injury and vaginal / uterine prolapse.

Table 3 illustrates the summary statistics for the 25 remaining events and includes number of herds, lactations and cases. As expected from previous studies, the highest number of cases occurred with mastitis and metritis which are two of the more common ailments on dairies. There also was a high concentration of lameness in many herds. Although there was a substantively lower concentration of the health events abortion, hypocalcemia, cystic ovary,

displaced abomasum and retained placenta than the top three conditions, there are a high number of herds affected.

Table 3. Numbers of herds, lactations and cases by health event code and name.

Health event	Herds	Lactations	Cases
ABCS = abscess	45	58 721	1 967
ABRT = abortion	456	334 214	2 462
BLDM = bloody milk	24	35 667	664
CALC = hypocalcemia	455	361 183	7 339
CLOS = clostridium	20	21 971	1 720
CYST = cystic ovary	563	322 887	18 254
DIAR = diarrhea / BVD	47	63 480	4 298
DIGE = digestive problems	336	318 106	9 653
D.A. = displaced abomasum	439	409 836	5 859
DOWN = downer	42	53 057	242
DYST = dystocia	191	179 551	3 134
EDEM = udder edema	49	60 564	1 525
INFU = mammary infusion	34	18 733	2 738
JOHN = Johne's	68	60 160	10 748
KETO = ketosis	269	290 329	10 536
LAME = lameness	550	468 274	59 922
MAST = mastitis	758	570 225	59 660
METR = metritis	654	540 991	45 740
PEYE = pink eye	63	56 544	286
PNEU = pneumonia	42	53 585	713
REPR = other reproductive problem	141	155 100	14 427
RESP = respiratory	354	342 985	6 439
RETP = retained placenta	530	436 138	11 638
SULC = stomach ulcer	20	28 039	1 248
WART = hairy heel wart	56	80 811	7 458

Results - incidence of health events

The relative impact of a specific disease on dairies was expressed by its frequency of occurrence and computed using lactation incidence rates (LIR) in the following manner:

$$LIR = \frac{\text{number of first occurrences of a specific health event in lactations}}{\text{number of lactations at risk}}$$

Table 4 lists LIRs for the 25 targeted health events by lactation number, mean across lactations and standard error of the mean. The final column includes mean incidence rates and 95% incidence range of each health event that were available from literature and were compiled by Parker Gaddis, *et al*. (2012). At least 10 citations were found for most diseases listed in this column with the exception of health events that are more typically reported in calves, such as diarrhea, digestive problems and respiratory problems.

Notice that LIRs were not found in the literature for thirteen diseases, most of which have much lower numbers of cases relative to other diseases. Exceptions were Johne's, other reproductive

problems and hairy heel wart, each of which had a relatively high number of occurrences and a relatively high LIR. However, 'other reproductive problems' is a combination of reproductive diseases so LIRs from literature would be irrelavent.

For diseases with corresponding literature citations, calculated LIRs were within the 95% incidence range from literature. With three exceptions, the mean LIRs were somewhat lower than the mean incidence from literature. For digestive problems, displaced abomasums and ketosis, the LIRs were only slightly higher than literature LIRs.

These results generally agree with findings from Parker Gaddis, *et al*. (2012) which were also derived PCDART data. LIRs for several diseases in the current study were markedly higher than the prior study. In fact, LIRs for hypocalcemia, cystic ovary, diarrhea / BVD and respiratory problems were double. This might reflect changes in importance or prevalence of these diseases in more recent years.

Additionally, the health events from Parker Gaddis, *et al*. (2012) were from a more extended

time period (thirteen years versus four years) with only a one-year overlap with the current study. The current study also used dates of enrollment and withdrawal from PCDART to edit inclusion to complete calendar years. This edit allowed more time for some new users to become accustomed to PCDART before their data were included and it truncated inclusion for herds that withdrew from PCDART .

With the exception of bloody milk, the rate of incidence increased with lactation number which also generally agrees with Parker Gaddis, *et al*. (2012).

Table 4. Lactation incident rates by lactation, mean across lactations, and mean incidence from literature with 95% range.

Health event	**Lactation**	**Incident Rate LIR %**	**Mean (S.E.)Across lactations lactations (%)**	**Mean literature incidence[1] (95% range) [no. citations**
ABCS = abscess	1	2.50	5.03 (2.53)	
	2	3.34		
	3	5.19		
	4	5.03		
	5	9.08		
ABRT = abortion	1	1.41	1.89 (0.53)	
	2	1.47		
	3	1.78		
	4	2.08		
	5	2.70		
BLDM = bloody milk	1	2.73	3.15 (0.71)	
	2	2.58		
	3	3.26		
	4	2.84		
	5	4.33		
CALC = hypocalcemia	1	2.05	5.20 (3.44)	7.44
	2	2.33		(1.49, 21.75)
	3	4.43		[18]
	4	6.98		
	5	10.24		
CLOS = clostridium	1	5.74	7.67 (1.81)	
	2	6.59		
	3	6.84		
	4	9.68		
	5	9.53		
CYST = cystic ovary	1	5.02	7.32 (2.01)	9.05
	2	5.99		(0.76, 21.70)
	3	6.93		[21]
	4	8.64		
	5	10.02		
DIAR = diarrhea/BVD	1	3.09	5.27 (2.64)	5.88
	2	3.45		(2.77, 11.22)
	3	5.42		[5]
	4	4.71		
	5	9.69		
DIGE = digestive problems	1	2.53	3.84 (1.29)	2.60
	2	2.91		(0.20,6.89)
	3	3.47		[8]
	4	4.60		
	5	5.67		
DOWN = downer	1	0.71	1.53 (0.81)	
	2	0.84		
	3	1.40		
	4	2.04		
	5	2.63		

(to be continued ...)

(... to be continued)

Health event	Lactation	Incident Rate LIR %	Mean (S.E.)Across lactations lactations (%)	Mean literature incidence[1] (95% range) [no. citations
D.A. = displaced abomasum	1	2.08	3.18 (0.93)	2.67
	2	2.35		(0.56, 8.85)
	3	3.37		[11]
	4	3.87		
	5	4.20		
DYST = dystocia	1	1.91	2.82 (1.34)	5.29
	2	1.86		(0.80, 13.34)
	3	2.35		[14]
	4	2.89		
	5	5.09		
EDEM = udder edema	1	1.47	2.47 (0.96)	
	2	1.64		
	3	2.31		
	4	3.53		
	5	3.40		
INFU = mammary infusion	1	8.19	10.14 (2.34)	
	2	8.66		
	3	8.46		
	4	12.46		
	5	12.92		
JOHN = Johne's	1	9.39	11.88 (2.82)	
	2	10.27		
	3	9.88		
	4	14.44		
	5	15.41		
KETO = ketosis	1	3.96	6.27 (2.31)	5.07
	2	4.21		(0.32, 19.50)
	3	6.04		[21]
	4	7.78		
	5	9.34		
LAME = lameness	1	6.64	8.98 (2.41)	9.27
	2	7.27		(2.54, 30.44)
	3	8.12		[17]
	4	10.37		
	5	12.47		
MAST = mastitis	1	8.62	12.00 (2.97)	17.98
	2	10.18		(0.96, 39.13)
	3	11.56		[29]
	4	13.35		
	5	16.30		
METR = metritis	1	6.54	8.17 (2.14)	12.34
	2	6.23		(1.77, 35.50)

(to be continued ...)

(... to be continued)

Health event	Lactation	Incident Rate LIR %	Mean (S.E.)Across lactations lactations (%)	Mean literature incidence[1] (95% range) [no. citations
PEYE = pinkeye	1	0.90	1.28 (0.63)	
	2	0.79		
	3	1.01		
	4	1.39		
	5	2.33		
PNEU = pneumonia	1	1.43	2.09 (0.85)	
	2	1.89		
	3	1.54		
	4	2.05		
	5	3.54		
REPR = other reproductive problems	1	3.80	6.27 (2.58)	
	2	5.06		
	3	4.86		
	4	7.36		
	5	10.26		
RESP = respiratory	1	1.89	2.72 (0.84)	3.30
	2	2.13		(0.21, 7.11)
	3	2.46		[12]
	4	3.20		
	5	3.93		
RETP = retained placenta	1	3.04	5.49 (1.96)	8.02
	2	4.35		(2.33, 17.94)
	3	5.24		[30]
	4	6.80		
	5	8.00		
SULC = stomach ulcer	1	3.41	6.60 (3.11)	
	2	4.42		
	3	6.71		
	4	7.01		
	5	11.45		
WART = hairy heel wart	1	5.95	7.64 (2.59)	
	2	4.99		
	3	6.94		
	4	8.83		

[1]Calculated from Appuhamy *et al.* (2009); Barker *et al.* (2010); DeGaris and Lean (2008); Dubuc *et al.* (2010); Emanuelson *et al.* (1993); Faye (1992); Fleischer *et al.* (2001); Frei *et al.* (1997); Gay and Barnouin (2009); Groehn *et al.* (1992); Gröhn *et al.* (1989, 1995); Hamann *et al.* (2004); Heringstad *et al.* (1999); Miller and Dorn (1990); Mörk *et al.* (2009); Olde Riekerink *et al.* (2008); Stevenson (2000); Toni *et al.* (2011); Yániz *et al.* (2008).

Additional sources of data

The 1 423 herds that were evaluated are enrolled on a PCDART backup feature that sends data to DRMS servers to enable DRMS staff to assist in rebuilding the dairy farmer's entire database in the event of a disaster. Additionally, DRMS has permission to provide data from these farmers to advisors or consultants. Prior to edits, these 'backup' dairies represented 39% of PCDART users.

Other dairy farmers who are enrolled on PCDART rely on 'backup' systems that are on-farm, primarily because their communications systems are incapable of high-speed delivery of large disaster recovery data files to DRMS. However, health entries during the most recent test period are delivered from these 'non-backup' farmers to DRMS with other test day data that have been entered to accomplish test day processing. DRMS does not have complete definitions of the health events (only 4-character mnemonic) and DRMS does not have permission to deliver these data to advisors or to use for other purposes..

But an assessment of data from these 'non-backup' dairies found that they enter health events at a more modest rate when compared to similar sized 'backup' herds. Backup herds recorded a mean of 123 events per 100 cows per year and 65% of herds recorded a minimum of 10 usable events per 100 cows per year while 'non-backup' herds recorded a mean of 52 events per 100 cows per year.

For both types of herds, larger herds (number of cows>500) recorded useful data at almost twice the rate of smaller herds.

Table 5. Rate of recording for 'backup' herds and 'non-backup' herds in the centralized database.

Size (# cows)	Backup (# herds)	Backup rate of recording	Non-backup # herds	Non-backup rate of recording
< 100	308	106	462	36
100 - 499	864	102	880	49
500 - 999	173	191	84	126
> 1000	78	246	26	179
Total / avg.	1 423	123	1 452	52

Rate of recording the 34 targeted health events.

Conclusions

Based upon data from DRMS' PCDART on-farm herd management system, health incidence data that have been recorded by dairy farmers have LIRs similar to previous studies. However, the quality and quantity of available data probably could be improved by promoting and supporting the adoption and use of clear clinical signs for each disease.

In the past, dairy farmer leaders in the U.S. have objected to the delivery of their health data to centralized databases under the control of the federal government. But recent changes to transition the operational elements of the U.S. Genetic Evaluation Program to be under the auspices of the Council on Dairy Cattle Breeding, a private industry non-profit entity, should remove this impediment to centralized storage and use of health data from U.S. dairy farmers.

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