ARIZONA & NEW MEXICO DAIRY NEWSLETTER

COOPERATIVE EXTENSION

The University of Arizona®
New Mexico State University

JULY, 2002

Upcoming Events:

Arizona Dairy Production Conference

Department of Animal Sciences
The University of Arizona
October 17, 2002
Sheraton Phoenix Airport Hotel

(Look for the details in next month's newsletter)
(520) 621-3375

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This month's article

Evaluation of Thermal Status of Cattle Using Infrared Thermography

Robert Collier and Crista Coppola
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New Mexico State University Extension Dairy Website:
http://www/nmsu.edu/~dairy

The following videos are available for checkout from Mike Looper, New Mexico State University. To obtain a video call Kathy Bustos, (505) 646-3325 or kbustos@nmsu.edu and the video will be sent in the mail, pending availability. There is only one copy of each video available, so we request that videos be returned within two weeks. Note that four of the videos contain an English and Spanish version.

1. The Milking School. Utah State University. Spanish and English. 30 minutes
2. Fitting and Showing Your Dairy Animal....A Winning Experience. Department of Dairy Science, University of Wisconsin. 20 minutes
3. Proper Milking Procedure. University of Florida. Spanish and English. 12 minutes
4. Milking Machine Maintenance. University of Florida. Spanish and English. 16 minutes
5. The Basics of Vacuum and Milking Systems. DHIA Services, 1991. 53 minutes
6. Understanding Dairy Cattle Behavior to Improve Handling and Production. Livestock Conservation Institute, 1992
7. Managing Milking/Ordenar Lecheria. Spanish and English. 1999. 33 minutes
8. Get Milk! Joining A Dairy Crew. University of New Hampshire, 1999. 45 minutes

Need to Calculate Production Costs?

University of Wisconsin dairy farm management specialist, Gary Frank, has developed a Excel spreadsheet to calculate variable cost of production and total cost of production. To access the spreadsheet, go to http://www.wisc.edu/dairy-profit, click on Decision Making Tools, then go to costcwt.xls.

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EVALUATION OF THERMAL STATUS OF CATTLE USING INFRARED THERMOGRAPHY

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Introduction

Evaluation of the thermal status of cattle is essential to maintaining high levels of productivity. Adverse effects of thermal stress on lactating, growing and pregnant cattle are well documented Spain and Spiers, 1997, Ravagnolo et al, 2000, Ray et al 1992 . Obtaining core temperatures of cattle is difficult under practical management conditions requiring restraint of the animal or use of expensive telemetry equipment. Presently, commercial cattle operations use Temperature Humidity Index or THI as a general index of heat load on cattle Igono et al. 1992.

The THI combines relative humidity and air temperature into a single estimate of heat load. When THI values exceed 72 there are measurable adverse effects on cattle performance. However, this measure is not effective on estimating given heat loads at a point in time and does not accurately predict the animals ability to dissipate heat load. For example, if the THI index exceeds 72 and the producers are providing shade and fans to cool animals they still do not know if the animals are stress-free.

An alternative approach is to directly measure the surface temperature of the animal. The only routes of heat movement from the body core to the body surface are convection and conduction which require a thermal gradient. Therefore, the surface temperature must be below body temperature for the animal to move heat from its core to its skin surface for heat loss. Since core temperature of cattle is approximately 38.5 ^{0}C the skin surface temperature must be well below this temperature to move heat to the skin surface.

Methods

Infrared thermograms were captured of the udder (UIR) and side (SIR) using an infrared thermography camera (model eVS DTIS-500) manufactured by Emerge Vision[1]. Each image was taken using Look Up Table (LUT), color palette, of 01 and a total viewable temperature range (RNG) of 07-11; this allowed for the broadest spectrum in depicted color. Any artifacts, dirt, manure etc., were removed prior to imaging. Surface temperatures of the udder (UG) and side (SG) were also measured using an infrared temperature gun manufactured by Raytek® (Raynger® MX™ model RayMX4PU).

Images from the camera were stored on a compact flash memory card (SanDisk®) and subsequently downloaded to a laptop computer for analysis using software from Emerge Vision, diagnostic thermal imaging software system 500. The software permitted analysis of temperatures within a specific area using an ellipse drawn on the desired area.

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[1] eMERGE Vision Systems, Inc. 10315 102nd Terrace Sebastian, Florida 32958

The infrared camera and infrared gun were calibrated on a weekly basis using a copper globe painted flat black and a mercury thermometer. A hole was drilled in the top for water addition and insertion of a thermometer. The globe was filled with hot tap water and a mercury thermometer was inserted into the globe for temperature measurements for each calibration. At five-minute intervals, a camera image, infrared gun reading and thermometer reading were taken for three calibration measurements.

Calibration data were analyzed (Statview, 1998) to establish the correlation between the infrared measurements and mercury thermometer measurements. Correlation values were compared between the infrared camera and black globe thermometer, the infrared gun and black globe thermometer and between the infrared camera and infrared gun. Both infrared devices were highly correlated (>93%) with the black globe thermometer and the two infrared devices had a high correlation (91%) to each other, Table III-1 and Figure III-3.

The study period was June 19, 2000 to September 20, 2000. The average environment temperature for this period was 34°C with an average relative humidity of 32%. During the study period, the temperature humidity index (THI) ranged from 73.5 to 84.7.

Animals and Data Collection

Four hundred Jersey cows were split into two treatment groups, cooled and non-cooled and 100 cows in each group were treated with bovine somatotropin (bST) (POSILAC®). Treatment groups were balanced for parity, milk yield and days postpartum.

Cooled pens consisted of shade with fans and misters set to deliver approximately 750 cu.ft./m air and 3.78 gallons of water per hour per cow. Non-cooled pens consisted of shade only. Both groups were held in a similar cooled holding pen for approximately 30 minutes prior to milking each day.

Once a week, measurements were taken between one and four pm on eight randomly chosen animals from each treatment group. Respiration rates and surface temperatures of the udder and side were taken using an infrared thermography camera and an infrared temperature gun.

Statistical Analysis

Data were analyzed using a categorical model (SAS, 1996). An animal was classified as being in heat stress if respiration rate was greater than 85 respirations per minute. The models used to analyze the dependent variable heat stress included a separate model for each body temperature (SIR, UIR, SG or UG). Each model included the following independent variables: milk production the day prior to measurements, air temperature, stage of pregnancy, cooling treatment and bST treatment.

Results

All surface temperature measurements affected respiration rate ($P < .0070$) and therefore the classification of heat stress (RR>85 breaths/minute), Tables 1 and 2.The following variables also influenced respiration rate: temperature humidity index, bovine somatotropin treatment and cooling treatment ($P < .04$) Milk production the day preceding measurements and stage of pregnancy did not have an affect on respiration rate ($P > .05$).

The effect of environmental and animal factors on surface temperature measurements are shown in Table 2. Cooling lowered all surface temperature measurements. Advancing pregnancy was associated with decreasing side but not udder surface temperatures, this may be associated with greater heat loss capability in late pregnancy. Milk yield the day surface temperatures were recorded did not affect surface temperatures in this study, Table 2. Use of bST to increase milk yield was also not associated with an increase in body surface temperatures in this study, Table 2.

Cooling and bST increased milk yield and this effect was additive, Table 3. Thus, cooling was associated with lower body surface temperature and increased milk yield. Furthermore, cooling increased response of cows to bovine somatotropin, Table 3.

Discussion

This study was designed to determine if heat stress had an affect on surface temperature by infrared temperature equipment. An animal was classified in heat stress if measured respiration rate was greater than 85 breaths per minute. Bovine dissipate heat and maintain thermal homeostasis through two mechanisms, cutaneous respiration and respiratory evaporation. Individually, a cow does not have voluntary control over their rate of cutaneous evaporation, which is partially genetically determined. However, an animal can individually control and alter their rate of respiratory evaporation through altered respiration rates. Therefore, as ambient temperature increases respiration rates increase as well (Esmay, 1978).

This trend was shown in all treatment groups. When surface temperature increased in both treatments (37.8°C vs. 35.5°C), cooled and non-cooled, respiration rates also increased. The respiration rate for non-cooled cows was significantly greater than cooled cows (102 breaths/min. vs. 80 breaths/min.).

It is generally accepted that, ambient air temperature affects body temperature, both internal and external, and according to Lemerle and Goddard (1986), body temperature affects respiration rate. As body temperature increases due to lack of metabolic heat dissipation and environmental heat load, respiration rates increase as well. As is shown in the present data, cooled cows are maintaining normal body temperature without increasing respiration rate because enough heat is being shed through the skin.

From the body temperatures measured, side and udder, side temperature had the greatest association with respiration rate. Body surface temperatures are affected by the external environment an animal is exposed to, including air temperature, relative humidity, solar radiation and cooling processes, if any; and by internal factors such as, day in milk, milk yield, parity, water and dry matter intake, presence of exogenous bST and stage of pregnancy.

From this data we conclude that it is possible to evaluate thermal status of cattle without restraint using infrared thermography. Based on the relationship between skin surface temperature and respiration rate we conclude that a side surface temperature below 35^0 C is required to avoid increased core temperature and respiration rate. Furthermore, a simple infrared thermography gun which is available for approximately $100 can be used to monitor cattle under group housing conditions. This permits the producer to evaluate cooling requirements regardless of weather conditions outside the housing system.

References

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Table 1. Heat Stress sources of variance for SIR, UIR, SG and UG due to Temperature Humidity Index (THI), milk yield the day before (MilkPre), bST treatment, cooling treatment, stage of pregnancy and bST by cooling interaction.

		SIR R^2 = .357		UIR R^2 = .431		SG R^2 = .297		UG R^2 = .276	
Variance Source	df	MS	P	MS	P	MS	P	MS	P
THI	1	0.7017	0.7039	57.518	<.0001	4.4058	0.3762	2.558	0.4162
MilkPre	1	15.703	0.0737	4.86	0.1511	1.8651	0.5643	0.0171	0.947
bST	1	0.0556	0.9148	0.024	0.9193	8.4177	0.2221	1E-05	0.9987
Cooling	1	286.15	<.0001	190.1	<.0001	94.483	<.0001	212.92	<.0001
Stage of preg	3	33.824	0.0002	2.602	0.3448	39.932	0.0002	4.455	0.3279
bST x cooling	1	3.1095	0.4241	0.0543	0.8789	21.06	0.0548	0.1708	0.8335

SIR - side temperature from infrared camera
UIR - udder temperature from infrared camera
SG - side temperature from infrared temperature gun
UG - udder temperature from infrared temperature gun

Table 2. Heat stress adjusted means of cooling treatment, bST treatment, stage of pregnancy (open, 1st, 2nd or 3rd trimester) and bST by cooling interaction for SIR, UIR, SG and UG.

	SIR		UIR		SG		UG	
	LSMeans	Std. Error	LSMeans	Std. Error	LSMeans	Std. Error	LSMeans	Std. Error
nocool	37.66	0.33	40.25	0.23	35.77	0.40	37.50	0.28
cool	34.84	0.35	37.95	0.25	33.80	0.40	35.20	0.29
nobST	36.23	0.35	39.08	0.24	35.08	0.38	36.35	0.28
bST	36.27	0.34	39.11	0.24	34.50	0.41	36.35	0.29
Open	36.73	0.31	38.79	0.22	35.71	0.41	36.62	0.27
1st trimester	38.06	0.40	39.23	0.28	36.89	0.59	36.96	0.33
2nd trimester	37.06	0.27	38.76	0.19	35.13	0.33	36.49	0.23
3rd trimester	33.16	1.03	39.61	0.71	31.43	1.04	35.34	0.85
nobSTnoCool	37.50	0.42	40.26	0.29	35.59	0.49	37.53	0.35
nobSTCool	34.97	0.43	37.91	0.30	34.57	0.48	35.17	0.34
bSTnoCool	37.83	0.42	40.24	0.29	35.95	0.56	37.47	0.36
bSTcool	34.71	0.45	37.98	0.31	33.04	0.56	35.23	0.38

SIR - side temperature from infrared camera
UIR - udder temperature from infrared camera
SG - side temperature from infrared temperature gun
UG - udder temperature from infrared temperature gun

Table 3. Effect of Cooling and Bovine Somatotropin on Milk Yield in Jersey Cows.

Treatment	Group (n)	Avg Milk (kg)	Mastitis (new cases)	Metabolic Disorders
Not Cooled				
No rbST	101	20.5[a]	1[d]	2[d]
rbST	82	21.0[a]	4[e]	8[e]
Cooled				
No rbST	97	22.4[b]	3[e]	7[e]
rbST	83	23.7[c]	3[e]	6[e]

[a,b,c] Differs within column ($P < 0.01$).
[d,e] Differs within column differ ($P < 0.05$).

High Cow Report
JUNE, 2002

MILK

Arizona Owner	BarnNum.	Age	Milk	New Mexico Owner	BarnNum.	Age	Milk
* Mike Pylman Dairy	4117	4-4	37,780	* Do-Rene Dairy	825	5-06	37.330
* Stotz Dairy West	19566	4-1	37,350	Ken Miller Dairy	495	5-11	36,907
* Red River Dairy	208	3-3	36,924	* Do-Rene Dairy	1865	5-06	36,770
* Stotz Dairy West	12449	4-6	36,730	* Breedyk Dairy	7619	5-06	36,520
* Stotz Dairy West	11556	5-1	36,410	* Hafliger Dairy	715	5-06	36,520
* Stotz Dairy West	13582	3-7	36,230	Ken Miller Dairy	571	5-03	36,039
* Stotz Dairy West	12752	4-3	35,720	* Desperado Dairy	8272	4-03	35,290
* Stotz Dairy West	11537	5-1	34,880	* Do-Rene Dairy	1972	5-06	35,270
* Stotz Dairy West	6738	6-2	34,740	S.A.S. Dairy	1670	6-10	34,998
* Arizona Dairy North	47093	6-5	33,999	* Hafliger Dairy	6723	4-03	34,830

FAT

Arizona Owner	Barn Num	Age	Fat	New Mexico Owner	Barn Num	Age	Fat
* Red River Dairy	297	3-3	1476	Ken Miller Dairy	495	5-11	1448
Paul Rovey Dairy	7023	5-7	1415	* Hafliger Dairy	715	5-06	1444
* Stotz Dairy West	6738	6-2	1381	* Hafliger Dairy	6636	4-03	1421
* Mike Pylman Dairy	3329	5-3	1367	* Hafliger Dairy	5452	5-06	1383
* Hillcrest Dairy	2242	4-0	1364	* Hafliger Dairy	6534	4-03	1277
* Red River Dairy	297	4-4	1348	S.A.S. Dairy	2107	7-04	1260
* Stotz Dairy West	12449	4-6	1345	* Maldra Mac Dairy	865	6-06	1256
* Stotz Dairy West	13484	3-8	1344	* Desperado Dairy	8272	4-03	1247
* Mike Pylman Dairy	6154	2-2	1343	* Maldra Mac Dairy	1500	4-11	1240
* Red River Dairy	543	4-4	1320	* Hafliger Dairy	6826	4-03	1237

PROTEIN

Arizona Owner	Barn Num	Age	Protein	New Mexico Owner	Barn Num	Age	Protein
* Stotz Dairy West	19566	4-1	1093	* Desperado Dairy	8272	4-03	1105
* Hillcrest Dairy	2242	4-0	1072	* Hafliger Dairy	715	5-06	1101
* Stotz Dairy West	11537	5-1	1062	* Desperado Dairy	8152	4-03	1078
* Red River Dairy	208	3-3	1055	* Hafliger Dairy	6636	4-03	1072
Shamrock Dairy	15718	6-0	1044	* Do-Rene Dairy	1865	5-06	1058
* Stotz Dairy West	13040	3-11	1041	S.A.S. Dairy	1670	6-10	1056
* Stotz Dairy West	11998	4-9	1038	* Do-Rene Dairy	825	5-06	1050
* Mike Pylman Dairy	4117	4-4	1034	* Desperado Dairy	8213	4-03	1047
* Stotz Dairy West	13166	3-11	1028	* Do-Rene Dairy	1883	7-06	1036
* Stotz Dairy West	13582	3-7	1019	* Breedyk Dairy	7619	5-06	1030

* 3X day milking

JUNE, 2002
ARIZONA - TOP 50% FOR F.C.M.[b]

OWNERS NAME	Number of Cows	MILK	FAT	3.5 FCM	C. I.
* Red River Dairy	4042	27,345	975	27,637	13.4
* Stotz Dairy West	2161	27,337	960	27,389	14.8
University of Arizona Holsteins	163	26,192	949	26,716	13.7
Martha Linda Dairy	1842	25,320	919	25,852	13.2
* Mike Pylman Dairy	2497	25,279	896	25,461	14.4
* Stotz Dairy East	1530	25,352	866	25,005	11.5
Paul Rovey Dairy	428	24,394	861	24,511	13.0
* Hillcrest Dairy	2417	24,791	844	24,408	13.8
Desert Ridge Dairy, LLC2	499	24,112	845	24,130	13.5
* Arizona Dairy Company North	2649	23,858	843	23,998	14.3
University of Arizona Brown Swiss	126	22,414	881	23,980	14.8
* Zimmerman Dairy	1228	23,699	842	23,902	14.6
* DC Dairy, LLC	1074	23,179	846	23,742	13.4
* Wigwam Dairy	1421	23,041	826	23,358	15.1
* Arizona Dairy South	3183	23,470	812	23,217	14.0
* Del Rio Holsteins	1219	23,099	809	23,108	13.3
Butler Dairy	618	23,144	807	23,095	14.2
* Saddle Mountain Dairy	2123	23,363	765	22,507	13.4
* Dairyland Milk Company	2409	22,344	758	21,953	13.9
* Dutch View Dairy	1633	22,053	761	21,876	13.9
* Danzeisen Dairy, LLC	1261	20,842	768	21,467	13.1
Parker Dairy	4387	20,455	758	21,138	14.5
Goldman Dairy	1999	20,879	742	21,061	13.7
* Gladtime West Holsteins	339	21,365	728	21,045	15.1
* RG Dairy, LLC	1322	21,055	733	20,991	13.7
* Del Rio Brown Swiss	154	20,536	741	20,898	12.8

TOP 50% ACTUAL MILK - OFFICIAL & UNOFFICIAL HERDS FOR NEW MEXICO

OWNERS NAME	Number of Cows	MILK	FAT	3.5 FCM	C. I.
* Pareo Dairy #1	1400	25,762	934	26,287	13.7
* Hafliger Dairy	1803	25,372	930	26,054	13.3
McCatharn North Dairy	1047	25,025	859	24,752	13.4
* Do-Rene Dairy	2560	24,860	842	24,405	13.7
Ken Miller Dairy	345	24,813	829	24,174	13.6
* Pareo Dairy #2	2745	24,419	910	25,317	13.1
* Tallmon Dairy	525	23,989	855	24,239	14.6
* S.A.S. Dairy	2061	23,818	860	24,246	13.5
Price's Roswell Farm	2760	23,578	859	24,126	13.7
* Vaz Dairy	1529	23,112	797	22,919	13.8
* Hide Away Dairy	2150	22,945	764	22,312	12.9
* High Plains Dairy	1677	22,307	824	23,009	13.9
Breedyk Dairy	2832	22,197	730	21,437	13.8

*3X a day milking
[b] Average Milk & Fat figure may be different from monthly herd summary; figures used are last day/mo.

ARIZONA & NEW MEXICO HERD IMPROVEMENT SUMMARY FOR OFFICIAL HERDS TESTED JUNE, 2002

		ARIZONA	NEW MEXICO
1.	Number of Herds	62	28
2	Total Cows in Herd	76,531	45,406
3.	Average Herd Size	1,234	1,622
4.	Percent Days in Milk	88	86
5.	Average Days in Milk	218	201
6.	Average Milk - All Cows Per Day	63.2	62.3
7.	Average Percent Fat - All Cows	3.5	3.5
8.	Total Cows in Milk	67,347	39,049
9.	Average Daily Milk for Milking Cows	71.6	73.7
10.	Average Days in Milk 1st Breeding	82	75
11.	Average Days Open	152	149
12.	Average Calving Interval	13.9	14.0
13.	Percent Somatic Cell - Linear 0-4	87	77
14.	Percent Somatic Cell - Linear 5-6	9	18
15.	Percent Somatic Cell - Linear 7 & above	4	5
16.	Average Previous Days Dry	63	68
17.	Percent Cows Leaving Herd	31	35
	***************************	********	*********
			STATE AVERAGE
	MILK	21, 927	21,860
Percent Butterfat		3.6	3.6
Percent Protein		3.0	3.0
Lbs. Fat		791	787
Lbs. Protein		658	653

ARIZONA COOPERATIVE EXTENSION
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