Impact of Grazing and Heat Stress on Intake of Dairy Cows

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Allowing dairy cows the opportunity to graze pasture is a practice frequently used by dairy producers. Some producers use grazing as the primary source of forage while others use it as a supplement to a partial total mixed ration (pTMR). There are several challenges associated with grazing—especially during periods of heat stress—that producers should take into account to maintain intake and production, especially when grazing comprises a significant amount of the feed allotment. This bulletin will provide information on these challenges and changes that can be used to minimize the impact of heat stress.

The biggest challenge with grazing dairy cows is maintaining adequate dry-matter intake (DMI) to provide the energy they require for grazing plus what they need for milk synthesis. Pasture DMI is affected by forage availability, bite size, and grazing time. Most producers use an intensive rotational grazing system to maintain forage availability and quality. Researchers at Iowa State University reported that the bite size and grazing time vary with season (Table 1). Although grazing time and eating rate increase during the summer and fall, lower bite size resulted in lower DMI. Some of the difference relates to a difference in forages grazed and forage availability within each season, but it also reflects the negative effect of heat stress. This work was conducted in the Midwest, which has less chronic heat stress than is typically experienced in Georgia.

	Spring	Summer	Fall
Grazing time, min/day	490	540	570
Eating rate, bites/min	59	65	65
Bite size, oz dry matter	.018	.011	.010
Intake, lb dry matter/day	32.0	24.6	22.9

From “Feeding dairy cows on quality pasture” (LT-106), by L. Tranel and D. Combs, 1999, Iowa State University Extension.

When grazing, the maintenance energy requirements of the cow increase because of the additional energy used for walking to and from the pasture, changes in elevation in the pasture, and the additional time spent grazing. The increase ranges from 5% to 10% depending primarily on the distance to the pasture and the pasture’s elevation changes. The 2001 edition of Nutrient Requirements for Dairy Cattle did not include any adjustment for heat stress other than a reduction in DMI. However, since that time research has reported that the decrease in DMI only accounts for 40%–50% of the reduced milk yield observed because of heat stress (Rhoads et al., 2009).

Simulated Effects

To illustrate the effect of grazing and heat stress on potential milk yield, the NRC model was used to predict allowable milk for a 1,250 lb cow, 175 days in milk, and producing 60 lb of milk containing 3.5% fat and 2.9% true protein. The ration was balanced for cows grazing lush grass approximately 0.25 miles from the milking parlor and cows were fed a pTMR based on corn silage. The same TMR (without pasture) was modeled for cows housed in a total confinement system at the same intake.

Two other simulations were modeled using pasture and pTMR with a 10% reduction in DMI, which would be expected when grazing, or 10% lower DMI and a 7% increase in maintenance to model grazing under heat stress conditions. The results (Table 2) illustrate how the combination of reduced DMI and increased maintenance requirements associated with grazing and heat stress contribute to the reduction of available energy to sustain milk yield. Metabolizable protein (MP) intake would have supported higher milk yield, but the energy intake was not sufficient to utilize the higher MP intake. The model does not completely account for the additional energy that would be used to convert the excess protein consumed into urea, which would be excreted in urine.

	TMR	Graze 1	Graze 2	Graze 3
DMI, lb/day				
Pasture	—	14.60	13.15	13.15
TMR	44.10	29.50	27.95	27.95
Total	44.10	44.10	41.15	41.15
NE_L, Mcal/day				
Maintenance	9.3	10.4	10.4	11.1
Lactation	18.7	18.7	18.7	18.7
Total	27.9	29.1	29.1	29.8
NE_L intake	29.1	29.1	26.2	26.2
NE_L Balance	+1.2	+0.1	-2.6	-3.6
MP, lb/day				
Maintenance	1.62	1.62	1.48	1.59
Lactation	2.60	2.60	2.60	2.60
Total	4.22	4.22	4.08	4.19
MP intake	4.31	4.31	3.83	3.84
MP Balance	+0.09	+0.09	-0.25	-0.35
Milk allowance, lb/day				
NE_L	63.7	60.2	50.8	48.6
MP	62.1	62.1	54.3	51.9

Note. Data show intake (DMI), energy (NE_L), metabolizable protein (MP) balance, and milk allowance for cows fed either (a) total mixed ration (TMR), (b) grazed plus partial TMR (pTMR) and no change in DMI or heat stress (Graze 1), (c) grazed plus pTMR and 10% reduction in DMI because of heat stress (Graze 2), or (d) grazed plus pTMR with 10% reduction in DMI and 7% increase in maintenance requirements because of heat stress (Graze 3). The information was calculated using the NRC (2001) model for a 1250 lb Holstein cow, 175 days in milk, producing 60 lb milk containing 3.5% fat and 2.9% true protein. The TMR used corn silage as the sole forage and was balanced to meet the needs of the Graze 1 simulation.

Studies on the Effects of Different Feeding Systems

Researchers at Pennsylvania State University compared the production response of high-producing Holsteins provided one of three feeding systems: (a) pasture plus concentrate; (b) a combination of pasture plus a pTMR; or (c) a complete TMR. The pastures were a combination of smooth bromegrass, orchardgrass, and Kentucky bluegrass that would provide more energy than Georgia's warm-season grasses (bermudagrass, crabgrass, bahiagrass, etc.). The DMI of cows on the grazing system was 20% less than that observed for the TMR group in confinement (Table 3).

	Grazing	Grazing+pTMR	TMR	SEM
DMI, lb/day	47.6[a]	55.6[b]	58.9[c]	1.1
CP, lb/day	10.4	10.6	9.9	0.2
NE_L, Mcal/day	35.3[a]	40.2[b]	43.7[c]	1.5
Milk, lb/day	62.8[a]	70.5[b]	84.0[c]	2.6
3.5% FCM, lb/day	59.3[a]	68.1[b]	80.7[c]	2.2
Fat, %	3.13[a]	3.35[b]	3.30[b]	0.05
Protein, %	2.82[a]	2.95[ab]	2.99[b]	0.05
MUN, mg/dl	14.9[a]	12.0[b]	10.6[c]	0.4

Note. Cows were fed either pasture plus concentrate (grazing), pasture plus a partial total mixed ration (grazing + pTMR), or a total mixed ration (TMR).

a, b, c Means in the same row with different superscripts differ ($p < 0.05$).

From "Performance of high producing dairy cows with three different feeding systems combining pasture and total mixed rations," by F. Bargo, L. D. Muller, J. E. Delahoy, and T. W. Cassidy, 2002, *Journal of Dairy Science, 85*(11), p. 2948–2963 (https://doi.org/10.3168/jds.S0022-0302(02)74381-6).

Supplementing the pasture with a pTMR increased DMI compared with grazing only, but cows fed a TMR had the highest DMI. Milk yield followed a similar pattern as DMI. No differences were observed in crude protein (CP) intake, but energy (NEL) intake was lowest for grazing, intermediate for grazing + pTMR, and highest for TMR. The different energy intake among the diets was due to DMI rather than the energy content of the diets which averaged 0.74, 0.72, and 0.74 Mcal/lb for grazing, grazing + pTMR, and TMR, respectively. The pasture contained more than 20% CP throughout the grazing season and was very digestible, resulting in lower milk fat concentration for the grazing group compared with the other two feeding systems. The excess CP relative to energy intake resulted in higher concentrations of milk urea nitrogen (MUN) in the milk as the cows were not able to utilize the CP from the pasture as efficiently.

Dairy Producers in Georgia

Many Georgia producers who graze also feed a pTMR to maintain higher DMI and milk yield. This approach also provides more flexibility in the feeding program when pastures don't grow as expected, either because of drought or cold weather, or when transitioning from warm to cool season forages in the fall or cool to warm season forages in the spring. The pTMR should be fed in a trough or portable feed wagon as feeding a pTMR on the ground will result in significant feed losses (estimated at 40%–50%). If a feed pad is constructed, it should provide evaporative cooling for the cows while they are eating.

Research in Australia reported improvements in milk yield for cows provided supplemental forage and access to a feeding pad with 80% shade and sprinklers between 9 a.m. and 2 p.m. when the temperature-humidity index (THI) was greater than 72 (Granzin, 2006). Figure 1 shows the milk yield response for cows that were provided access to the feeding pad with or without supplemental alfalfa hay compared with the cows left on the pasture with access to trees in the fence row. The improvements were more noticeable as THI increased. Moving cows to the feed pad when THI < 72 decreases milk yield, most likely because of lower intake since the cows would have continued eating. The body temperature of the cows that were provided access to the feeding pad was lower than that of the cows remaining on pasture, indicating that the shade and sprinklers were effective in reducing heat load.

Figure 1. Effects on Cows' Milk Yield of a Feeding Pad With or Without Hay.

The change in milk yield of cows with access to a feeding pad with shade and sprinkler, with (red bars) or without (black bars) access to alfalfa hay, from 9 a.m. to 2 p.m., compared to cows remaining on pasture with access to shade provided by trees in the fence row. The milk yield of cows on pasture ranged from 46.8–50.2 lb/day.

Adapted from "Cooling and forage supplementation of grass-fed Holstein cows during hot conditions," by B. C. Granzin, 2006, *Tropical Animal Health and Production, 38*, p. 146 (https://doi.org/10.1007/s11250-006-4317-4).

Most Georgia producers who graze have a sprinkler system mounted on an irrigation pivot to provide evaporative cooling while the cows graze. In a Georgia field study, the body temperature of the cows cooled under a pivot did not increase greatly during the day (Figure 2). However, the body temperature of the cow, measured using a temperature probe inserted into the vagina, increased when moved to or from the pasture to the milking parlor or feeding pad. The increase was greatest in the afternoon when the ambient temperature was highest. A prolonged increase in body temperature occurred at night when the sprinklers were not operating, except on farm A which continued operating the pivot until 10 p.m. (Hour 20). After dark the cows lay down, which limits the air movement around their bodies that dissipates heat, especially when the THI exceeds 75. These cooling systems reduce heat stress and support higher intake and milk yield compared to no supplemental cooling.

Figure 2. Vaginal Temperatures of Cows on Three Dairies.

Line graph showing the variation in vaginal temperature of cows from different farms over a 24-hour period, with notations indicating periods of milking and pivot cooling. Temperatures increase when moved to or from the pasture, and the increase was greatest in the afternoon when the ambient temperature was the highest.

The solid lines represent the periods when cows were exposed to pivot cooling on pasture for each of the farms. The asterisks represent the approximate times that cows left and returned to pasture, respectively. Dashed lines indicate a range correlating to p value.

From "Evaluation of cooling in 3 grazing dairy farms in Georgia, USA," by R. M. Orellana Rivas, J. K. Bernard, and S. Tao, 2019, *Applied Animal Science*, *35*(6), p. 637 (https://doi.org/10.15232/aas.2019-01910).

Summary

Cows allowed to graze have higher maintenance requirements and are not able to maintain the same intake or milk yield as cows in confinement. The drop in DMI can be minimized by providing either a supplemental pTMR or additional forage. When possible, a pivot fitted with sprinklers provides effective evaporative cooling for cows while grazing. If a pivot is not available, producers should consider using a feeding pad with shade and sprinklers to cool the cows while providing additional forage during the hottest times of the day. The use of showers in the exit lane to soak cows before they walk back to the pasture will minimize the increase in body temperature normally observed, especially in the afternoons. During periods of extreme heat stress, a cow's body temperature likely will increase at night when she lays down and the winds are not sufficient to provide cooling. Currently, research has not identified an effective means for cooling cows on pasture at night.

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