Managing and Feeding Lactating Cows in Hot Weather

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The modern dairy cow is similar to a factory, consuming and processing large quantities of raw materials (feedstuffs) and producing a large volume of high quality product (milk). It is essential that the flow of these raw materials (nutrients) not be reduced or interrupted if milk yield of the cow is to be maintained. Hot and humid environmental conditions stress the lactating dairy cow and reduce intake of the nutrients necessary to support milk yield and body maintenance. In Georgia, weather conditions are sufficiently hot and humid to reduce performance of dairy cows for five months or more each year. This is very costly to production, but is a great opportunity to improve profitability if the dairyman successfully meets the challenge presented by heat stress.

This publication presents methods which can be used to minimize the stress on dairy cows during hot weather and enhance production during the hot summer months.

What Is Heat Stress?

The primary factors that cause heat stress in dairy cows are high environmental temperatures and high relative humidity. In addition, radiant energy from the sun contributes to stress if cows are not properly shaded. As the environmental temperature increases, the difference between the temperature of the cow's surroundings and her body decreases, and her reliance on evaporative cooling (sweating and panting) to dissipate body heat increases. However, high relative humidity reduces the effectiveness of evaporative cooling and during hot, humid summer weather the cow cannot eliminate sufficient body heat and her body temperature rises. The tremendous amount of body heat that the high yielding dairy cow produces is helpful in cold climates but is a severe liability during hot weather.

One way to measure the combined effect of temperature and humidity is use the temperature-humidity index (THI). Table 1 contains the THI that results from different combinations of temperatures and relative humidities. A THI exceeding 72 is sufficient to cause minor heat stress and cause a response such as reduced feed intake in the cows. Note that with high relative humidity, the temperature that causes a THI of 72 can be quite low. Note also the danger zone for THI (Table 1). When the THI is in this range, livestock are at risk and environmental modification will be necessary to avoid sharp declines in production, and in some cases to avoid death losses.

Table 1. Table of temperature-humidity indexes (THI)[1] at varying temperatures and relative humidities.

Temp		- - - - - - - - - - Relative Humidity, % - - - - - - - - - -																			
(F)	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	
	- - - - - - - - - - THI - - - - - - - - - -																				
70	64	64	64	65	65	65	66	66	66	67	67	67	68	68	68	69	69	69	70	70	
71	64	65	65	65	66	66	66	67	67	67	68	68	68	69	69	70	70	70	71	71	Heat stress begins.
72	65	65	65	66	66	67	67	67	68	68	69	69	69	70	70	70	71	71	**72**	**72**	
73	65	66	66	66	67	67	68	68	68	69	69	70	70	71	71	71	**72**	**72**	73	73	
74	66	66	67	67	67	68	68	69	69	70	70	70	71	71	**72**	**72**	73	73	74	74	
75	67	67	67	68	68	68	69	69	70	70	71	71	**72**	**72**	73	73	74	74	75	75	
76	67	67	68	68	69	69	70	70	71	71	**72**	**72**	73	73	74	74	75	75	76	76	Sharp drops in production occur.
77	67	68	68	69	69	70	70	71	71	**72**	72	73	73	74	74	75	75	76	76	**77**	
78	68	68	69	69	70	70	71	71	**72**	73	73	74	74	75	75	76	76	**77**	**77**	78	
79	68	69	69	70	70	71	71	**72**	73	73	74	74	75	76	76	**77**	**77**	78	78	79	
80	69	69	70	70	71	**72**	**72**	73	73	74	75	75	76	76	**77**	78	78	79	79	80	
81	69	70	70	71	**72**	72	73	73	74	75	75	76	**77**	**77**	78	78	79	80	80	81	
82	69	70	71	71	**72**	73	73	74	75	75	76	**77**	77	78	79	79	80	81	81	82	Danger Zone
83	70	71	71	**72**	73	73	74	75	75	76	**77**	78	78	79	80	80	81	82	82	83	
84	70	71	**72**	73	73	74	75	75	76	**77**	78	78	79	80	80	81	82	83	83	84	
85	71	**72**	72	73	74	75	75	76	**77**	78	78	79	80	81	81	82	83	84	84	85	
86	71	**72**	73	74	74	75	76	**77**	78	78	79	80	81	81	82	83	84	84	85	86	
87	**72**	73	73	74	75	76	**77**	77	78	79	80	81	81	82	83	84	85	85	86	87	
88	72	73	74	75	76	76	**77**	78	79	80	81	81	82	83	84	85	86	86	87	88	
89	73	74	75	75	76	**77**	78	79	80	80	81	82	83	84	85	86	86	87	88	89	
90	73	74	75	76	**77**	78	79	79	80	81	82	83	84	85	86	86	87	88	89	90	
91	74	75	76	76	**77**	78	79	80	81	82	83	84	85	86	86	87	88	89	90	91	
92	74	75	76	**77**	78	79	80	81	82	83	84	85	85	86	87	88	89	90	91	92	
93	75	76	**77**	78	79	80	80	81	82	83	84	85	86	87	88	89	90	91	92	93	
94	75	76	**77**	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	
95	76	**77**	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	
96	76	**77**	78	79	80	81	82	83	85	86	87	88	89	90	91	92	93	94	95	96	
97	**77**	78	79	80	81	82	83	84	85	86	87	88	89	91	92	93	94	95	96	97	
98	77	78	79	80	82	83	84	85	86	87	88	89	90	91	93	94	95	96	97	98	
99	78	79	80	81	82	83	84	85	87	88	89	90	91	92	93	94	96	97	98	99	
100	78	79	80	82	83	84	85	86	87	88	90	91	92	93	94	95	97	98	99	100	

[1]THI = td - (0.5 x RH)(td - 58), where td = dry bulb temperature (degrees F) and RH = relative humidity in decimals.

The effects of hot, humid weather are costly to the dairyman in many ways. In addition to reduced milk yield (15 to 40%), cows have lower milk fat content, impaired reproductive performance, and greater susceptibility to health problems during hot weather. Feed intake declines and the energy which is consumed by the cow is used less efficiently for milk production. There are many tools available to help the dairyman combat heat stress, but management must be excellent if performance is to be maintained. Aspects of hot weather management for lactating dairy cows that will be addressed include: (1) management of the cow's environment, (2) feed ration management, (3) feed bunk management, and (4) cow management.

Practical Management to Reduce Heat Stress

Shades and Cooling

The easiest and most obvious way to help heat-stressed cows is to provide adequate **shade.** Direct sunlight adds a tremendous heat load to the cow, but heat energy that is reflected from areas exposed to the sun such as concrete floors, barn walls and other exposed surfaces also add to the cow's heat load. Shading reduces the black globe environmental temperature (a measure of temperature and radiant energy) and lowers the rectal temperature and respiration rate of cows, increasing feed intake and milk yield (Table 2). Gains in milk production of 10 to 20 percent occurred where shaded and unshaded cows were compared.

Table 2. Effect of shade on heat stress indicators in lactating dairy cows.

Measurement	Shade[a]	No Shade	% Change	Shade[b]	No Shade	% Change
Black globe temp., degrees F	86.2	101.8	-18.1	84.4	105.8	-25.3
Rectal temp., degrees F	101.7	103.3	-1.6	102.6	105.4	-2.7
Respirations/minute	78	115	-47.4	83	133	-60.2
Daily feed intake, lb.				45.6	37.0	+23.2
Daily milk yield, lb.				42.8	37.5	+14.1

[a]Adapted from Collier, et.al., 1981. *J. Dairy Sci.* 64:844.
[b]Adapted from Scheider, et.al., 1984. *J. Dairy Sci.* 67:2546.

In times past when dairy herds were smaller and most cows were pastured, adequate shade was provided by trees. In larger herds the greater cow density has killed many trees. Mudholes created under the trees increase the incidence of mastitis and slow milking parlor throughput because of the greater time required to clean dirty cows before milking. Because of these negative effects, use of trees for shading has declined.

Numerous shading alternatives are available to the producer. **Mesh shadecloth** is lightweight, available in numerous sizes, has reinforced grommets that make installation easy, and can be used in portable or permanent installations. A commonly used shadecloth is an 80 percent mesh, which means 80 percent of the sunlight is blocked. Because 80 percent of the sunlight is reflected and 20 percent passes through, shadecloth is not as effective as other types of shading, but it is far better than no shade at all. The passage of some sunlight through the mesh may help to dry the area underneath the shade. Ease of installation and relatively low cost lends shade cloth to many uses. **Portable shades** using mesh shadecloth and placed in pastures can be moved so that mudholes are not created.

Loose housing barns provide shade for cows without the cost of freestalls or the concrete floors. These barns have a sand base mounded in the center of the barn to minimize accumulation of moisture. The bedding must be cleaned and maintained regularly to prevent pitting and fresh sand must be added as needed. However, separate feeding facilities must be maintained.

An option which is becoming quite popular is a **feeding/cooling barn** with or without freestalls. These barns provide shade and the convenience of drive-through feeding. These barns have high roofs which are steeply pitched to minimize the transfer of heat energy from the metal roof to the cows and to encourage air flow, venting hot air out the ridge vent and drawing in cooler air from the eaves.

In the hot, humid environment of the southeast shading alone does not provide adequate heat stress relief. Additional cooling in the form of **fans and sprinklers** is usually beneficial and is easily installed in these barns. Sprinkling (not misting) the cow with water to fully wet her body and using fans to evaporate the water cools the cow and encourages greater feed intake and milk production. Research shows an 11 percent increase in milk yield when cows were cooled with fans and sprinklers compared with shading alone. Sprinklers and fans are usually placed next to the feedbunk so that the feeding area is the coolest place on the farm, helping to encourage greater feed intake.

Shading Concerns and Precautions

Orientation of the shading structure relative to the path of the sun is important to minimize intrusion of sunlight under the structure during summer. Notice that little sunlight penetrates underneath a structure with an east-west orientation in June, while the north-south orientation allows a great deal of sunlight penetration. In December, the east-west orientation allows some sunlight under the structure, providing warmth in the cooler months. An east-west orientation is most desirable so that the barn is cooler in summer while allowing sunlight to warm the barn during cold months.

Overcrowding under shades reduces their effectiveness. A minimum of 38 to 48 square feet per cow is needed to minimize heat build up between the animals. Cows should have access to adequate shading at all times; in the holding pen, at the water trough, at the feed bunk, and while resting.

Highly reflective roofs reflect sunlight and minimize heat transfer to the cattle underneath. White galvanized metal or aluminum roofing is very reflective. A layer of insulation underneath the roofing also minimizes heat transfer. Roofs high enough to minimize heat transfer but low enough to reduce intrusion of sunlight are necessary. An eave height from 11.5 to 14.5 feet is desired.

Water from sprinklers must not be blown into freestalls by fans, which creates a mastitis hazard, or onto the feed, which increases spoilage. Sprinkler water can be confined to desired areas by choosing the right nozzle and placing nozzles correctly in the barn. Also, having fans and sprinklers run in sequence (for example 13.5 minutes for fans, 1.5 minutes for sprinklers) so that fans and sprinklers do not run at the same time will keep water from being blown where it is not wanted. A cooling system which is thermostatically controlled ensures that the system runs as long as temperatures are high, and not just until the evening milking shift is over. If cows are sprinkled with water in the holding pen they must be dry by the time they are milked. High capacity fans directing air at floor level help to dry cows' udders prior to milking.

Feeding and Nutritional Management During Hot Weather

Water is the most important nutrient for the cow. It should always be available, should be fresh and clean, and there may be advantages to providing cool water during summer. Waterers should be cleaned regularly and should be conveniently located to encourage drinking. Shading the water trough encourages drinking during the hot portion of the day and may help to keep the water cool. Research shows that chilled drinking water helps to cool the cow and improves feed intake. Preventing cool well water from warming by shading troughs or using insulated waterers may be beneficial.

Energy is a critical nutrient because of the decline in feed intake which occurs during hot weather. Because energy is usually the nutrient which is most limiting in dairy diets, especially during high production and heat stress, the diet must be made more energy dense to provide sufficient energy to maintain milk yield. Increasing the energy in the diet can be achieved by increasing **concentrates** (grains) and decreasing **forages** in the diet. However increasing concentrates to greater than 55 to 60 percent of the diet dry matter is risky and can

result in depressed milk fat content, acidosis, cows going off feed, laminitis, and reduced efficiency of nutrient use.

Added dietary **fat** is an excellent way to increase energy content of the diet, especially during sum-mer when feed intake is depressed. Fat is high in energy (about 2.25 times as much as carbohydrate), does not add starch to the diet (minimizing rumen acidosis), and may reduce heat load in summer. Added dietary fat often boosts milk fat test a point or two.

Dietary fat content should not exceed 5 to 6 percent of the total diet dry matter. Some sources of supplemental fat are listed in Table 3. Oilseeds such as whole cottonseed and whole soybeans are excellent sources of fat and are protein supplements as well. Tallows are also good fat sources. Manufactured rumen escape or "bypass" fats are specialty fats which are inert or inactive in the rumen. These are often used when high milk yield requires energy supplementation above that which can be supplied with oilseeds or tallows without causing digestive upsets. One rule of thumb when high fat addition is required is that ⅓ come from natural feed ingredients, ⅓ come from oilseeds or tallows, and ⅓ come from rumen bypass fats.

Table 3. Sources of supplemental fat for dairy cow diets.

	Nutrient Content[1]				Total Intake	Guidelines for Feeding
Source	N E_L (Mcal/lb)	TDN	Crude Protein	Fat	lb/day	% of diet
		---------- (%) ----------				
Cottonseed	0.01	96	23	20	6	12-15
Soybeans	.96	91	42.8	18.8	4-5	10-12
Tallow	2.65	177	----	99.5	1-1.5	2-3
Rumen escape fats[2]	----	----	----	----	----	----

[1]From National Research Council. 1989. *Nutrient requirements of dairy cattle.* Washington, D.C.: National Academy Press.
[2]Nutrient content and feeding rate depend on the product being used. Follow manufacturer's guidelines.

Often the amount of **crude protein** in summer diets must be increased because of lower feed intake. Because of decreased feed intake, careful attention must be given to the amount (pounds) of protein needed by the cow, not the percentage in the diet. Caution must be taken to feed adequate but not excess dietary crude protein. Excess dietary crude protein must be metabolized and excreted by the cow; a process which creates heat and consumes energy that could be used to produce milk. Rumen escape or "bypass" protein is usually beneficial for cows producing in excess of 60 pounds of milk daily. Bypass protein values of 36 to 40 percent of total dietary crude protein are desirable. The amount and type of bypass protein needed varies by the type of diet being fed, and your nutritionist should be consulted to help make decisions for your herd. Research indicates that heat-stressed cows benefit from bypass protein when simply shaded, but the benefit may be greater for those cows receiving extra cooling. Recent research indicates that diets should not contain an excess of 17 percent crude protein with greater than 62 percent degradable intake protein during hot weather. Again, however, rations should be formulated for adequate protein intake based on the amount of feed the cow is actually consuming.

Fiber is required in the cow's diet for proper rumen function. However the digestion and metabolism of fiber creates more heat than the digestion of concentrates, and the heat-stressed cow will reduce the amount of forages she consumes relative to concentrates if allowed to select between the two. This upsets the ration balance and can lead to reduced fat test, rumen acidosis and digestive upsets. There are several steps which can be taken to prevent cows from sorting and selecting their diets.

1. Chop hays and mix into a total mixed ration.
2. Use silages as the sole forage source and mix into a total mixed ration.
3. Use wet ingredients such as wet brewers grains and silages to make dry hay diets wetter and more palatable.

4. Add water to dry diets during mixing to improve intake and reduce sorting.
5. Feed high quality, more palatable forages.

Chopping hays for mixing into total mixed rations also helps to reduce waste and improves utilization of lower quality hays when necessary.

The fiber content of the ration should be reduced slightly to encourage greater intake in hot weather. The ADF content should not be less than 18 percent and NDF not less than 28-30 percent of ration dry matter to maintain normal rumen function. As mentioned previously, increasing concentrates to greater than 55 to 60 percent of the ration is risky, because of the reduced amount of effective fiber in the diet. Probably of greater importance than the forage:concentrate ratio is the quality of the forage in the diet. Excellent quality forage helps to maintain feed intake and is especially important during the summer. When excellent quality forage is used in your nutrition program, more forage can be included in the ration. In addition to greater feed intake, feed costs are often lower and fiber levels can be maintained at a higher level.

The requirement for some **mineral elements** increases during hot weather. Table 4 contains National Research Council mineral recommendations for lactating cows and suggested mineral levels for hot weather feeding. Mineral content of the ration should be boosted before the onset of hot weather so that the cow is prepared and a sharp drop in production can be avoided.

Table 4. Recommendations for selected dietary mineral elements.

Mineral	NRC[1]	Heat Stress
	(% of diet dry matter)	
Potassium	.9	1.2-1.5
Sodium	.18	.4-.6
Magnesium	.2	.3-.35

[1]National Research Council. 1989. *Nutrient requirements of dairy cattle*. Washington, D.C.: National Academy Press.

Buffers such as sodium bicarbonate should be used during hot weather, especially in low fiber, high concentrate diets. Diets should contain at least .75 percent sodium bicarbonate on a dry matter basis. This amounts to a minimum of .34 pound of buffer per day for a cow consuming 45 pounds of dry matter. Magnesium oxide at .35 to .4 percent of diet dry matter also helps to maintain milk fat test.

Succulent feedstuffs are those feeds which are high in moisture, including silages, green chop forages, and by-products such as wet brewers grains. Cows like succulent feeds and their inclusion in the dairy ration may encourage intake during hot weather. However a ration that is too wet may restrict intake so care must be taken to not exceed 50 to 55 percent moisture in hot weather rations. Succulent feeds spoil more rapidly than dry feeds, especially during hot weather, and feed bunks should be cleaned daily to prevent spoiled feed from reducing feed consumption.

Feeding Management During Hot Weather

The biggest limitation to milk production during hot weather is adequate feed intake. Table 5 shows the effect of increasing temperature on maintenance needs and feed intake of the cow. Declining intake with increasing temperatures means that the density of all nutrients must increase in the diet if milk yield is to be maintained. Management during hot weather should be aimed at whatever measures are necessary to encourage feed intake because it is difficult to provide sufficient nutrients if feed intake is severely depressed. There are several phases of management involved with care of dairy cows during hot weather.

Table 5. Relative changes in maintenance requirements, dry matter (DMI) and water intake, and milk yields with increasing environmental temperature.

	Required for 59.5 lb milk		Expected intakes and milk yield		
Temperature (degrees F)	Maintenance requirements (% of req. at 68 ° F)	DMI required (lb)	DMI (lb)	Milk yield (lb)	Water intake (gal)
68	100	40.1	40.1	59.5	18.0
77	104	40.6	39.0	55.1	19.5
86	111	41.7	37.3	50.7	20.9
95	120	42.8	36.8	39.7	31.7
104	132	44.5	22.5	26.5	28.0

Adapted from National Research Council. 1981. *Effect of environment on nutrient requirements of domestic animals.* Washington, D.C.: National Academy Press.

Feeding management includes:

1. Delivering to the cow a ration that is similar to the one that is formulated
2. Providing adequate feed for all cows at all times
3. Providing adequate bunk space for all cows
4. Creating a desirable environment around the feed bunk
5. Frequent cleaning of the feed bunk
6. Frequent ingredient and ration analysis to ensure accurate ration formulation
7. Purchase or harvest of high quality ingredients.
8. Minimizing drastic ration changes that force cows off-feed.
9. Use of total mixed rations to ensure consistent intake of a balanced diet with little sorting of ingredients.

As mentioned previously, shading and cooling are an important part of cow management during hot weather. However there are several other aspects of management which may improve performance.

If **grazing** is a part of your feeding program, cows will consume more if grazed very early in the morning or at night. During the day cows will seek shade. If cows are moved a long distance from pasture, heat stress will be increased, especially if cows are moved during the hot afternoon hours. Hurrying cattle to the barn further stresses the cow. Since long distances often separate pastures from the dairy barn, perhaps green chopping forage is an option. This allows the use of fresh green forage, allows better control of the ration and keeps cows near the barn, increasing the opportunity to cool the cow. Green chopping may also help improve forage utilization.

Frequent feeding provides fresh feed, stimulates the cow's curiosity and encourages more frequent eating, all desirable during hot weather. The heat associated with digestion of feed peaks about 3 to 4 hours after feeding. By feeding cows in early morning (5 to 6 a.m.), the heat of digestion peaks at 8 to 9 a.m., and allows the cow to dissipate some of that heat before the day gets hot. A cow fed at 8 a.m. will have her peak of heat production at 11 a.m. to noon when the day is hotter, which is undesirable. Similarly, cows fed during the evening will be more comfortable and likely to consume feed and their peak of heat production will occur during the night, when environmental temperatures are lower. In addition, frequent small meals result in less heat generated than fewer, but larger, meals.

Summary

Intensive management can reduce the impact of hot weather on milk yield and profitability. Prepare for hot weather before it arrives, and remember that dairy cows suffer from heat stress at lower temperatures than humans. Because the weather is comfortable for you does not mean that it is not costing production from your dairy cows. Prepare for hot weather by:

1. protecting cows from direct sunlight by providing shade.
2. providing additional cooling by using fans and sprinklers.
3. adjusting the ration to provide adequate protein, energy, minerals and vitamins.
4. providing high quality forage.
5. adding fats to the diet to supplement energy.
6. feeding smaller meals several times daily to promote intake.
7. feeding during the cooler periods of the day.
8. cleaning feed bunks daily to prevent feed spoilage.
9. providing unlimited clean, cool water.

By using good management techniques, high yields from lactating dairy cows can be maintained during hot weather.