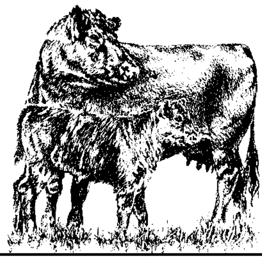

Winter Stress in Beef Cattle

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The climatic conditions that exist in an area have a bearing on the competitive position of that area's beef producers. Stress factors that occur because of winter weather can be compensated for by one of two management strategies, however.

One method is to provide shelters that will create an environment to enable animals to maintain the same production with a given amount of energy intake. A second method is to increase the animal's energy intake to enable it to withstand stress conditions. Severe conditions may dictate which method to use, or possibly even that both management strategies should be used.

Factors Creating Stress

Many climatic factors can increase stress on beef cattle. Factors that create stress during the winter months are cold, wind, snow, rain, and mud.

An understanding of these climatic factors and their magnitude can help livestock producers and feeders make management decisions that will reduce additional costs due to stress.

Cold Temperature

Cold is an obvious stress factor that increases an animal's demand for energy. Two basic questions for cattle producers are:

1. At what temperature are cattle of various types and classes affected by cold?
2. How much energy (feed) is required in overcoming the effects of cold stress?

Healthy cattle with average condition and hair coat have a 20° to 30°F temperature range, called a thermoneutral zone (TNZ), where efficiency and rate of gain are maximal. In this comfort zone, energy requirements for body maintenance are minimal, permitting the maximum amount of energy to be expended for growth and functions other than body maintenance. The ideal or critical temperature varies according to hair coat, moisture conditions, age, size of cattle, length of time exposed to the temperature difference, and how much wind exists with a given temperature, according to studies at the University of Alberta.

For this paper, the thermoneutral zone (TNZ) is the range in effective ambient temperatures that permits maximum efficiency and performance (Fig. 1).

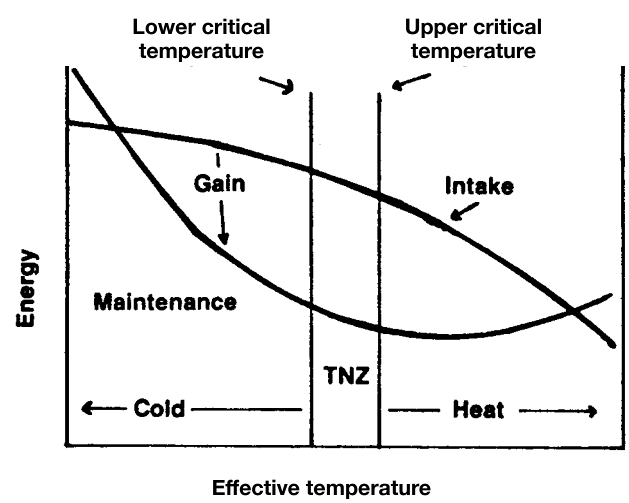

Fig. 1. Effect of temperature on rate of intake, maintenance energy requirement, and energy retained as product (gain).

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The term "effective temperature" is used by some scientists to deal with how conditions and temperature affect animals. Effective temperature is an index of the heating or cooling power of the environment in terms of dry bulb temperature. It would include any environment factor that alters environment heat demand such as solar radiation, wind, humidity, or precipitation. Formulas for calculating effective temperature for all environmental factors have not been developed. Wind-chill indexes are available. Table 1 was developed for cattle by Kansas State University.

While the ambient temperature and performance values may vary with different species, different diets, animal insulation, and management systems, the general pattern of reduced gain and lower efficiency is constant among animals exposed to cold. In some cases, mild cold stimulates appetite more than the realized increase in maintenance requirement. Consequently, a slight improvement in daily gain may be observed with mild cold, yet efficiency declines when temperatures fall below the lower critical temperature.

The lower critical temperature is the effective ambient temperature below which an animal must increase rate of heat production to maintain a constant body temperature. Lower critical temperature may be defined as the temperature at which rate of performance begins to decline as temperature becomes colder. Temperatures below the thermoneutral zone constitute cold stress. Cold stress may change from 32°F for a steer with a dry winter coat to 60°F if the coat is wet.

Table 2 presents estimates of the lower critical temperature for cattle of different hair coats.

Energy and Digestibility

Studies at Kansas State University with feedlot cattle related their expected energy requirement and gain at different temperatures. Table 3 shows the predicted gain and feed efficiency of a feedlot steer exposed to varying magnitudes (degrees below the lower critical temperature) of cold stress. The values are based on estimates of increased feed intake and maintenance energy requirements of an 880-pound steer.

Studies relating to increased feed energy requirements for cows, for calves being backgrounded or wintered for summer pasture, or for growing replacement heifers have not been as extensive as studies with finishing steers. This is largely due to the difficulty in measuring the energy requirement for production. University of Alberta research has suggested that from a base thermoneutral temperature of 15° to 20°C, the increase in maintenance

Table 2. Estimated lower critical temperatures for cattle with varying hair coats.

Hair coat	Feed level	Lower critical Temperature
		(°F)
Summer coat or wet	Maintenance	60
Fall coat	Maintenance	45
Winter coat	Maintenance	32
Heavy wintercoat	Maintenance	1 9

Table 3. Predicted performance of 880-pound finishing steer exposed to different magnitudes of cold.

Degrees of cold	Dry matter intake	NEm	NEg	Gain	F/G
(°F)	(lb)	(Mcal)	(Mcal)	(lb)	
32	22.7	6.9	6.3	2.76	8.2
24	23.4	8.0	5.9	2.62	8.9
14	23.8	9.1	5.5	2.44	9.7
5	24.3	10.2	5.0	2.27	10.7
-4	24.5	11.3	4.9	2.07	11.8
-13	24.5	12.4	4.2	1.78	13.7

Table 1. Wind-chill index for cattle.

Wind	Temperature (Fahrenheit)																																		
(mph)	-20	-18	-16	-14	-12	-10	-8	-6	-4	-2	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
0	-20	-18	-16	-14	-12	-10	-8	-6	-4	-2	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
2	-23	-21	-19	-17	-15	-13	-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47
4	-25	-23	-21	-19	-17	-15	-13	-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45
6	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	-4	-2	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
8	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	-4	-2	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
10	-31	-29	-27	-25	-23	-21	-19	-17	-15	-13	-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39
12	-33	-31	-29	-27	-25	-23	-21	-19	-17	-15	-13	-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37
14	-35	-33	-31	-29	-27	-25	-23	-21	-19	-17	-15	-13	-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35
16	-37	-35	-33	-31	-29	-27	-25	-23	-21	-19	-17	-15	-13	-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33
18	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	-4	-2	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32
20	-41	-39	-37	-35	-33	-31	-29	-27	-25	-23	-21	-19	-17	-15	-13	-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29
22	-43	-41	-39	-37	-35	-33	-31	-29	-27	-25	-23	-21	-19	-17	-15	-13	-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	13	15	17	19	21	23	25	27
24	-46	-44	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	-4	-2	0	2	4	6	8	10	12	14	16	18	20	22	24
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28	-52	-50	-48	-46	-44	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	-4	-2	0	2	4	6	8	10	12	14	16	18

requirement of feed energy is about 1 percent for each 1°C reduction in effective temperature. If feed intake is not increased to meet this increased requirement, the level of performance will decline.

If the environmental temperature changes above or below the TNZ, evidence suggests that reduced ration digestibility will further increase the maintenance feed requirement to meet the immediate energy demand. Some research indicates a decline of 1 to 4 percent in ration digestibility per degree centigrade during cold.

At the University of Alberta, 1,050-pound steers showed a decrease of 0.11 digestibility units per degree Centigrade drop in temperature. Digestibility was reduced 0.21 units per degree in 500-pound calves. The decrease in digestibility per degree drop in temperature tended to be smaller during late winter than in mid-winter. This suggests that winter-acclimated calves are more resistant to the depressing effects of cold on digestion.

Tables 4, 5, and 6 are estimates of the increased energy needs of different classes of cattle at varying magnitudes of cold. Calculations are based on a 1 percent increase in energy requirement for each degree in coldness and a 1 percent reduction in digestibility per 10°C fall in temperature below their critical temperature.

To use this information, one would need to determine the lower critical temperature of the animal in concern by using Table 2. After determining the lower critical temperature, the deviation could be calculated by subtracting the actual effective temperature in Table 1 from the critical temperature in Table 2. The metabolizable energy increase is determined using Tables 4, 5, and 6.

To determine the actual amount of feed needed to meet the increased requirement, divide the metabolizable energy per pound of the feed into the metabolizable energy increase from Tables 4, 5, and 6. Average analyses of metabolizable energy for some common feeds are shown in Table 7.

An example of this would be feeding alfalfa hay to a 1,000-pound pregnant cow. From Table 2 you have determined that her critical temperature is 32°F. The temperature outside is 18°F with a 10 mph wind. From Table 1 we can determine that the *efffective* temperature is 7°F. A deviation of 25 degrees below the critical temperature is calculated by subtracting 7°F from 32°F. From Table 4 a 25-degree deviation will require an additional 4.5 megacalories of metabolizable energy. Divide 4.5 megacalories by .95 Mcal in alfalfa hay, and the result is 4.7 pounds of additional alfalfa hay is required for a 24-hour average temperature of this kind.

Protein, Mineral, and Vitamins

Most data suggests that needs for protein, minerals, and vitamins are not altered during cold. Therefore, adjusting rations for the cold is essentially a matter of increasing energy to compensate for the increased rate of heat loss.

Table 4. Estimated feed energy increase at different magnitudes of cold below the lower critical temperature for 1,000-pound pregnant cows.

Deviation in °F below critical temperature[1]	Metabolizable energy increase
	(Mcal)
0 (Critical temperature)	.0
5	.9
10	2.0
15	3.2
20	3.6
25	4.5
30	5.4
35	6.4
40	7.3

[1]See Tables 1 and 2 for critical temperature.

Table 5. Estimated feed energy increase at different magnitudes of cold below the lower critical temperature for 770-pound yearlings.

Deviation in °F below critical temperature[1]	Metabolizable energy increase
	(Mcal)
0	.0
5	1.0
10	1.9
15	2.8
20	3.7
25	4.6
30	5.5
35	Above intake capacity
40	Above intake capacity

[1]See Tables 1 and 2 for critical temperatures.

Table 6. Estimated feed energy increase at different magnitudes of cold below the lower critical temperature for 550-pound calves gaining 1.5 pounds per day.

Deviation in °F below critical temperature[1]	Metabolizable energy increase
	(Mcal)
0	.0
5	.9
10	1.7
15	2.5
20	3.3
25	4.2
30	5.0
35	Above intake capacity
40	Above intake capacity

[1]See Tables 1 and 2 for critical temperatures.

Table 7. Metabolizable energy in common feeds.

Feed	Metabolizable energy
	(Mcal/lb)
Alfalfa hay	0.95
Bromegrass hay	1.00
Barley straw	0.67
Barley grain	1.36
Wheat	1.44
Corn	1.49

Since growth rates decline at temperatures below the critical level, a saving in protein could be made in feedlot cattle at these lower growth rates since protein can be reduced without further reducing performance.

Wind, Rain, and Mud

California researchers conducted environmental studies to determine the effect of wind, rain, and mud on the feed efficiency of yearling cattle in the feedlot. Table 8 indicates the amount of feed that was required per pound of gain to overcome the stress conditions. These conditions can be expensive to the cattle feeder if they exist for an extended time during the finishing period.

Table 9 indicates the effects of rain, mud, and wind on daily feed intake, daily gain, and feed efficiency of feedlot yearlings. If a feeder determines that one or more of these conditions will exist for a period of time he can determine how much he can afford to spend to reduce the stress conditions, based on the cost of feed and price of finished cattle.

Summary: Dealing with the "COLD" Facts of Winter Stress

Cattle exposed to cold require more energy for maintenance, and performance will be reduced if action is not taken to provide for it. Some suggestions for reducing winter stress and maintaining production in cold weather are:

1. Provide wind breaks and shelters to reduce wind, moisture, and mud.
2. Construct feedlots and buildings on south slopes and in areas where average temperatures are higher and moisture conditions are lower.
3. Adjust energy in rations to match expected performance for seasonal conditions.

Table 8. The effect of rain, wind, and mud on feedlot cattle performance.

Treatment	Initial weight	ADG	Feed intake	Feed gain
Concrete, wind, rain	648	2.77	22.2	8.01
Concrete, wind	634	3.23	20.8	6.44
Concrete, shelter	654	3.44	22.0	6.44
Mud, shelter	658	2.67	20.0	7.49
Mud, wind	625	2.47	19.7	7.97

From 9th California Feeders' Day, 1969, University of California.

Table 9. Effect of environment on feedlot performance (2/18/69 to 3/15/69, 650-pound yearlings).

	Daily feed	Daily gain	Feed/lb gain
Effect of rain[1]			
No rain:	20.8	3.23	6.44
Rain	22.2	2.77	8.01
% change	+6.7	-14.2	-24.4
Effect of mud			
No mud:	21.4	3.34	6.41
Mud:	19.8	2.57	7.70
% change	-7.5	-23.1	-20.1
Effect of wind[2]			
No wind:	21.0	3.06	6.86
Wind:	20.3	2.85	7.12
% change	-3.3	-6.9	-3.8

[1]Rain: 7.2 gallons per minute for 10 minutes in each hour.

[2]3.5 to 4.3 miles per hour.

4. This paper makes estimates of cold stress based on mean 24-hour temperatures. Brief (several hours) wind chill and cold stress will be less severe than 24-hour continuous cold stress.
5. Provide bedding during severe cold weather to permit cattle to lie down without directly contacting the frozen ground.
6. Cattle will voluntarily seek protection from rain, wind, and mud if it is available to them. If cattle are provided with modest protection, either by natural means or manmade structures, their exposure will be intermittent rather than continuous. The severity of the "effective temperature" can be greatly reduced by intermittent exposure provided by shelter.

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