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COLLEGE OF AGRICULTURE
Lexington, Kentucky 40546

COOPERATIVE EXTENSION SERVICE

Agricultural Engineering Update

Structures & Environment | Soil & Water | Energy | Safety | Crop Processing | Power & Machinery

AEU-91

Shade Options for Grazing Cattle

by
Larry W. Turner, Extension Agricultural. Engineer

Dairies in Kentucky lose more in milk production from heat stress as opposed to cold stress. Beef herds can also benefit from shade structures to reduce heat stress, thus improving feed efficiency and reproduction. Particularly in bef operations where fescue-based pastures with high-endophyte fescue are used, shade is a must! In other situations, the need for shade must be balanced against the tendency for animals to congregate under the shade and thereby reduce feed intake.

Research data are limited as to the benefit of shade. In one study in Arizona, shade improved milk production by 7.5 % when placed over the feed bunk as compared to a control situation with no shade. In Kentucky, even more benefit should be obtained, since much higher humidities are common, and possibly less night cooling is available.

Recent research conducted on UK's Animal Research Center farm indicated that beef cows and calves showed improved gains with shade in Spring and early Summer heat stress periods (an increase of 1.25 lb/day for cows, 0.41 lb/day for calves in a May measurement period with heat stress on endophyte infected fescue). In addition, deep body temperatures during the Spring period appeared to be 0.5 to 1.4 ^{o}F higher for non-shaded cattle as opposed to shaded animals. Based upon this study, the results suggested that if adequate shade is not present in the hotter summer period, no shade at all may be better than a limited shade amount. Limited shade may actually be a detriment to performance and well-being, as animals crowd under the small shades and reduce their cooling potential. For pasture situations, producers should strongly consider providing shade for dairy cows in most situations during the summer, and probably also for beef breeding stock. For stocker animals, the value is more questionable, except in the case of animals grazing on high-endophyte fescue.

Types of Shade for Pasture Situations

Shade is not often conveniently placed for rotational grazing systems. Often some paddocks have shade while others do not. The following alternatives can be used for shade in a rotational grazing system.

✐ ***Natural shade*** is the lowest cost alternative, but is not often in the proper location and care must be taken to avoid killing trees with too high a cow density. Strategic plantings can be used over time to create a natural shade environment. Placing shade trees on the west side of pasture areas is most desirable.

✐ ***Permanent shade*** can be provided by constructing barns or sheds, but is not often in the proper location in the grazing system and can be costly.

✐ ***Portable, low-cost shades*** can be built from 2.5" pipe and welded into a frame sturdy enough to take the abuse from cattle. For rotational grazing, the frames can be made portable and moved with the animals, or moved to different locations to avoid high manure build-up in a particular location. For covering, shade cloth will allow air movement while providing shade. Use 80% shade cloth for such structures. Another option that provides additional insulation value and complete shade is to use sheet metal or woven wire with straw or hay for insulation. However, the construction and maintenance of these type roofs for portable shades is greater.

Frames should have a skid-type bottom member to allow moving from paddock to paddock if necessary. Dimensions of 10'x20' are practical maximums for portable shade size.

Shade Requirements for Portable Shades

It is difficult to provide portable shades to meet the desired shade amount of approximately 40-60 ft^2/ head for mature cows on pasture. A practical compromise is to provide shade at about 75% of the requirement, using Table 1 as a guide. For example, a 30-cow herd of beef cows would require 5 or 6 portable shades to allow adequate shade for those animals, using 10'x20' portable shades.

Table 1. Suggested shade requirements for beef and dairy cattle.

Animal Type	**Space Requirement (ft^2 /hd)**
400 pound calves	15-20
800 pound feeders	20-25
Beef cows	30-40
Dairy cows	40-50

Note: These recommendations based upon limited UK research results and previous experience; additional research is needed regarding the benefits and optimum size to improve production, welfare, and economics.

Summary

Some general guidelines for planning shade systems, developed from experience and demonstrations, can be summarized as follows:

1) For high-producing animals, shade should be provided for at least 75% of the herd in controlled grazing systems, particularly for dairy or beef cows, or animals grazing high-endophyte fescue. This can be accomplished with portable shade structures, which may be moved to alternate locations in the grazing system.

2) 80% shade cloth should be used for a covering, and securely attached to the frame. The shade cloth should be removed in the winter, and stored.

3) Shade placement will affect the animal grazing patterns and forage utilization. Observe animal patterns and adjust locations of shades to improve utilization.

A plan, including a bill of materials, for a portable shade structure is available through your County Extension Office or the UK Plan Service.

References

Paul, R.M., L.W. Turner and B.T. Larson. 1999. Effects of shade on production and body temperatures of grazing beef cows. In: 2000 KY Beef Cattle Report; UK College of Agriculture Publication PR-117,

UK Plan No. KY.II.772-16. Cattle Shade. UK CES Plan Service. Dept. of Biosystems and Ag. Engineering.

Updated 5/00

PR-417

AGRICULTURAL EXPERIMENT STATION
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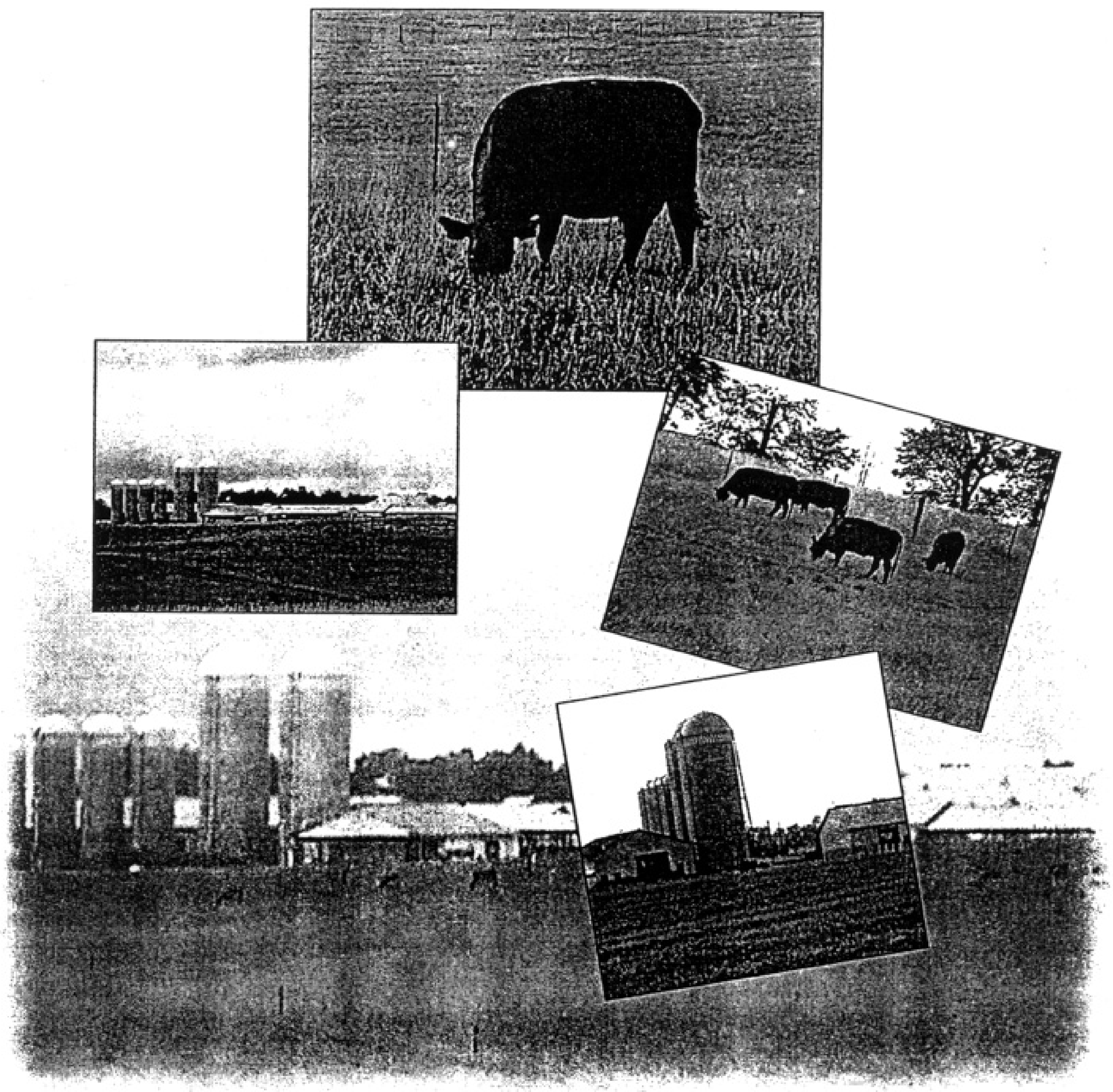
2000 KENTUCKY BEEF CATTLE RESEARCH REPORT



Rain simulation periods 1, 3, and 5 (after waste application) indicated higher levels of total phosphorus, and mineralization of ortho-phosphorus was higher for these periods by at least .002 ppm over RS2, 4, and 6 (followed 21-day rest periods). Organic and mineral components of waste treatment enhanced mineralization and subsequent availability of phosphorus. Net accumulation of soil ortho-phosphorus (3.39 ppm) and fescue total phosphorus (1,547 ppm) in waste treatment over control verifies that this pasture system recycled pnosphorus effectively. Furthermore, nutrient recycling through grazed plants results in fewer losses of nutrients in pasture runoff water.

The various grazing/forage management treatments were successful in maintaining differences in available forage dry matter (Table 8). The ranking of undergraze > 8-inch > 4- inch > overgraze was consistent ($P < .05$) throughout the experiment. Waste-treated plots show a numerical advantage in available forage dry matter compared to the control (non-waste treated) from RS2 through RS6, but these differences were not statistically different ($P >. 05$) because of high variability in estimates. The estimates of available forage dry matter in Table 8 do not reflect yield of forage during the experiment, but standing forage at the time of sampling.

Table 8. Tall fescue dry matter availability, lb/ac.

	Rain Simulation[a]						
Treatment	**RS1**	**RS2**	**RS3**	**RS4**	**RS5**	**RS6**	**SE[b]**
Control	1048	1009	1148	2806	3307	3048	1585
Waste	1680	1482	2680	4162	5550	4328	
Overgrazed	788^{ex}	894^{ex}	650^{ex}	2660^{ey}	2246^{ey}	3190^{efy}	263
4-inch	1410^{efx}	849^{ex}	1326^{ex}	3320^{efy}	3134^{fy}	2792^{ey}	
8-inch	2034^{fgx}	1733^{fx}	2874^{fy}	3994^{fz}	6151^{gz}	3842^{fz}	
Undergrazed	2572^{gx}	2071^{fx}	4710^{gy}	5663^{gz}	8854^{hz}	5468^{gz}	

[a]LS means, paired row values with different superscripts (x, y, z) differ ($P < .05$); column values with different superscripts (e, f, g, h) differ ($P < .05$).

[b]Standard error.

Effects of Shade on Body Temperatures and Production of Grazing Beef Cows

R.M. Paul and L.W. Turner, Biosystems and Agricultural Engineering, and B.T. Larson, Animal Sciences

Summary

The effects of shade upon beef cow body temperature and productivity were evaluated. Portable, pipe-constructed frames were draped with shade cloth in pastures with cow/calf pairs and stocker steers. Cows were equipped with data loggers, which simultaneously accumulated ambient temperature and body temperature. Body temperature was measured by ear probes at the tympanic membrane. Cattle were weighed at 28-day intervals.

The body temperature data, although not statistically significant, indicates that body temperatures of cows may be lowered slightly (.5° to 1.4° F) through the use of shade. Cows, calves, and growing steers tended to gain more weight per day with access to shade compared to those without access to shade. Numerical advantages in daily weight gains for cattle given shade over those not offered shade were 1.25 lb for cows, .41 lb for calves, and .89 lb for steers.

Introduction

Cattle attempt to maintain a constant body temperature of about 101.3°F. This is accomplished by balancing internal heat production and external heat gain with external heat loss. When ambient air temperatures exceed some critical level, which varies from animal to animal, the total heat gained by the animal exceeds its heat loss capabilities, causing core body temperature to increase. Extended periods of extreme heat or cold or abrupt changes from one to the other without acclimatization can negatively affect cattle productivity, health, and well-being. A complete understanding of the interaction between an animal and its environment requires understanding the interaction between a number of dynamic, ambient conditions. Dry bulb air temperature is a principal thermal measure but alone cannot represent the thermal environment experienced by cattle. Factors such as humidity, solar radiation, and wind velocity interact with ambient air temperature to affect the animals' ability to maintain stable body temperatures.

Fescue toxicosis presents a significant challenge for cattle production in the southeastern and midwestern regions of the United States. Tall fescue is a cool-season grass that is grown on 26-31 million acres in the United States. A large proportion of this fescue is infected with the endophytic fungus *Neotyphodium coenophialum*. The ergot alkaloids produced by tall fescue and *N. coenophialum* are potent vasoconstrictors that hinder the animals' ability to dissipate heat. These ergots cause several problems for cattle; the most common condition is known as fescue toxicosis, or summer syndrome. The effects of fescue toxicosis may be generalized by reduced performance, impaired health status, and reduced comfort of the animal. These effects are similar to those caused by heat stress; however, the ergot alkaloids increase the severity of heat stress for the animal.

Modification of the animals' environment may be required to maintain acceptable cattle production during heat stress periods. Methods to alter the animals' microenvironment include shade cooling, misting, evaporative cooling, and air conditioning. Shading, by adding shade structures, is the most economical means of reducing heat stress in grazing animals. Shade structures decrease the radiant heat load on an animal by removing the portion of the total heat load associated with solar radiation. This research investigates the use of shade for relieving the problems associated with heat stress in beef cows. Tympanic (tympanic membrane within the ear) temperatures and production characteristics are measured to estimate the need for shade and eventually determine the proper placement of shade structures within the pastures. The results of this study may prove useful to beef producers throughout this region of the United States.

Procedures

The University of Kentucky's Animal Research Center (Woodford County) is evaluating grazing management and legume interseeding in endophyte-infected tall fescue pastures. There are 12 15-acre pastures included in the study. All pastures were originally seeded with tall fescue (KY 31), which is infected with the endophytic fungus, *Neotyphodium coenophialum*. Six of these pastures are grazed in a two-paddock rotation and referred to as "low rotation," and six are grazed in a six-to-12 paddock rotation known as "high rotation." Six of these pastures have been interseeded with Alfa-Graze™ alfalfa. Each pasture has a centrally located, one-ball automatic insulated waterer. There are no trees or other permanent shade producing structures in any of the 12 pastures. Pasture terrain is classified as gently rolling and consists of predominantly Maury, Dunning, and Nolin soils. The existing project has four treatments, which include the following management practices: low rotation fescue, high rotation fescue, low rotation fescue/alfalfa, and high rotation fescue/alfalfa. Each treatment has three pasture replications. Two of the three pastures in each treatment have been assigned to either a shade or a no-shade treatment. The two test pastures were chosen based on the previous year's forage production/availability, endophyte infection levels, and slope. The two pastures which were most similar within treatment in the above characteristics were assigned to this project, and the shade or no-shade treatments were randomly assigned.

There were 96 Angus or Angus-crossbred cow/calf pairs grazing the 12 pastures. Eight cow/calf pairs were randomly assigned to each of the 12 pastures. Three of the eight cows, in both the shade and no-shade pastures of each treatment, were randomly chosen for temperature instrumentation.

Tympanic temperatures were measured by inserting the probe approximately 6 inches into the ear canal. Measurements were made at two-minute intervals using custom data loggers (Stowaway XTI108C+36+46) with a 24-inch external thermistor (TMC2-1T, Onset Computer Corporation). Onset Computer Corporation makes a variety of one-channel loggers with different memory sizes and temperature ranges. The best accuracy achieved with standard commercial Stowaway models is ± .7° F. The diurnal variation in body temperature of cattle varies from .9° to 2.2° F in thermoneutral conditions. For this reason, improved accuracy is needed and can be achieved by narrowing the temperature range of the data logger. The custom data logger has a temperature range of +96.8° to +114.8° F and an accuracy of ± .2° F.

The cow/calf pairs were initially placed in the pastures on April 9, 1998. The first data collection period took place during the week of May 7–May 14, 1998. This data set was taken in an attempt to obtain body temperature records in "thermoneutral" conditions. A second data collection occurred the week of July 1–8, 1998. Although somewhat cooler than normal, this period should provide data that is representative of an average summer in Kentucky. The third and final collection period took place from August 18–24, 1998, in an attempt to catch a small heat wave that came through central Kentucky.

The artificial shade structures used for this experiment are made of 80% shade cloth. The structures are 12 x 24 ft, providing a total shade area of 288 ft^2. The shade cloth is 10 ft in height. Placement of the shade changes in all pastures as often as the high-rotation pastures' shades are moved. Shade placement is ultimately determined by the grazing patterns of the cattle.

Temperature data from this trial were analyzed on the basis of average body temperature, maximum body temperature, and the diurnal range of body temperature using the SAS computer program.

Results and Discussion

The maximum ambient temperature of approximately 84.2° F occurred on May 13 (Figure 1). Despite this relatively low maximum ambient air temperature, the average and maximum body temperatures were approaching 104° F and 106° F, respectively. There are two factors that likely caused these unusually high body temperatures. This was the first heat wave that came through the area. Prior to May 13, the maximum ambient air temperature was well below 77° F. Over the course of 48 hours, the maximum ambient temperature rose nearly 15° F, giving the animals no time for acclimatization. A second explanation may be that the animals' forage dry matter intake is relatively high at this time of year when forage quality and ergot alkaloid content is high. Consuming high amounts of endophyte-infected tall fescue increases the amount of ingested ergot toxins. Because the toxins are concentration-dependent, the animals' susceptibility to heat stress increases. Although overt fescue toxicosis symptoms are generally associated with higher ambient temperatures of midsummer, unusual early-to-midspring warm fronts can cause dangerous hyperthermic conditions to develop.

From Table 1 and Figures 3 through 11, it can be seen that body temperatures of animals with access to shade were most often lower than body temperatures of animals without access to shade. These differences, however, did not prove to be significant ($P > .05$). There were no differences in measured performance traits due to the grazing management or pasture composition (P > .05).

Weight gains for cows, calves, and steers during the month prior to shade installation were similar among all pastures (P > .05). After a month of shade vs no-shade treatment, animals with access to shades had higher (cows P < .001, calves P < .05, and steers P < .005) weight gains for the period (Table 2).

Data for the third month of the trial is currently being analyzed. A detailed analysis of the weight gain data should be similar to that of the temperature data, with the only difference being that the measured data will be weight gains rather than body temperatures.

Table 1. Tympanic temperatures of beef cows grazing endophyte-infected tall fescue.

Rotation	Forage	Shade	Average	Maximum	Range
			° F, ± standard deviation[a]		
Low	Fescue	Yes	101.5 ± .5	104.4 ± .4	2.3 ± .5
Low	Fescue	No	101.5 ± .1	105.1 ± .3	2.9 ± .7
High	Fescue	Yes	101.1 ± 0	104.9 ± .6	3.1 ± 1.1
High	Fescue	No	101.7 ± .9	106.2 ± .9	3.2 ± 0
Low	Fescue/alfalfa	Yes	101.3 ± 0	104.0 ± 0	2.2 ± 0
Low	Fescue/alfalfa	No	101.7 ± 0	105.1 ± 0	2.7 ± 0
High	Fescue/alfalfa	Yes	101.7 ± 0	105.3 ± 0	2.5 ± 0
High	Fescue/alfalfa	No	102.7 ± .9	106.3 ± 1.1	2.7 ± .4
Total	Fescue and fescue/alfalfa	Yes	101.5 ± .4	104.7 ± .4	2.5 ± .8
Total	Fescue and fescue/alfalfa	No	101.8 ± 1.0	105.6 ± .8	2.9 ± .7

[a]Standard deviation listed as ± 0 indicates one observation per treatment.

Table 2. Weight gain/loss/head/day for beef cows, calves, and stocker steers grazing endophyte-infected tall fescue, month before and month after shades installed[a].

Rotation	Forage	Shade	Cows	Calves	Steers
			lb, ± standard deviation		
Low	Fescue	Yes	2.20 ± 1.41	2.25 ± 1.43	3.70 ± 2.20
			-.24 ± 4.3	**2.03** ± 1.37	**1.41** ± .51
Low	Fescue	No	1.83 ± 2.51	2.36 ± 1.57	2.93 ± 3.46
			-.42 ± 1.79	**1.46** ± 1.34	**.60** ± 1.41
High	Fescue	Yes	3.00 ± 1.85	2.20 ± .97	5.31 ± 1.98
			-.07 ± .79	**1.79** ± .77	**.68** ± 1.83
High	Fescue	No	2.49 ± .66	2.51 ± .77	2.91 ± 2.45
			-.60 ± 3.86	**1.41** ± 1.32	**1.48** ± 1.21
Low	Fescue/alfalfa	Yes	1.17 ± 2.47	2.23 ± 1.10	2.12 ± 5.27
			1.74 ± 1.63	**1.92** ± 1.06	**3.20** ± 1.28
Low	Fescue/alfalfa	No	2.87 ± 2.56	2.25 ± .77	3.77 ± 4.85
			-.79 ± 3.15	**1.57** ± 2.43	**1.21** ± 2.27
High	Fescue/alfalfa	Yes	2.23 ± 1.52	2.20 ± 1.41	2.76 ± 8.11
			-1.04 ± 1.12	**1.74** ± .46	**1.37** ± 1.54
High	Fescue/alfalfa	No	2.34 ± 1.48	2.54 ± 1.26	4.78 ± 1.72
			-2.25 ± 2.18	**1.43** ± 1.04	**-.13** ± 2.47
Total	Fescue and fescue/alfalfa	Yes	2.12 ± 3.42	2.23 ± 1.43	3.48 ± 8.84
			.24 ± 4.78	**1.87** ± 1.21	**1.68** ± 2.82
Total	Fescue and fescue/alfalfa	No	2.38 ± 3.06	2.40 ± 1.61	3.59 ± 4.67
			-1.01 ± 3.44	**1.46** ± 2.31	**.79** ± 3.40

[a]4/9 to 5/7 and **5/7 to 6/2-3.**

Figure 1. Ambient temperature and relative humidity over the last week of the trial.

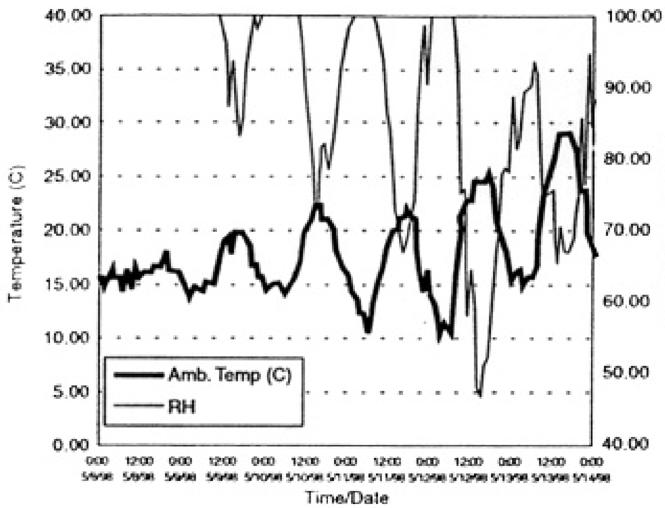


Figure 2. Deep body temperature for cow # C137.

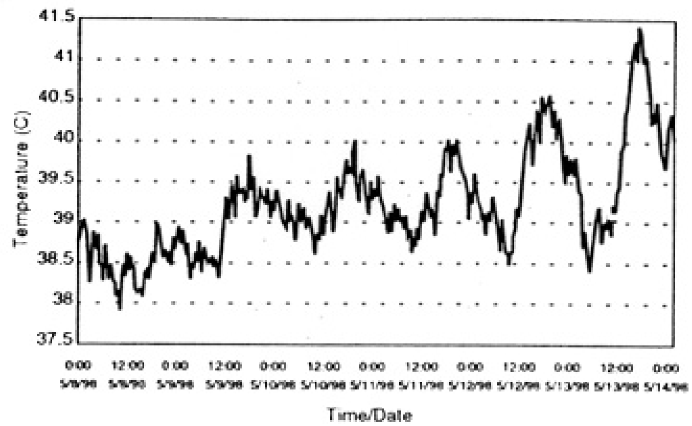


Figure 3. Average and maximum body temperature for cows on low rotation fescue/alfalfa pastures.

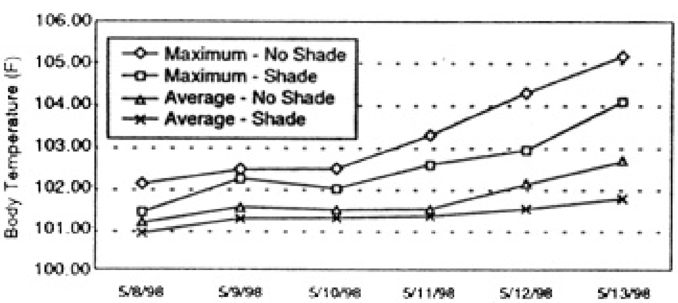


Figure 4. Average and maximum body temperature for cows on low rotation fescue pastures.

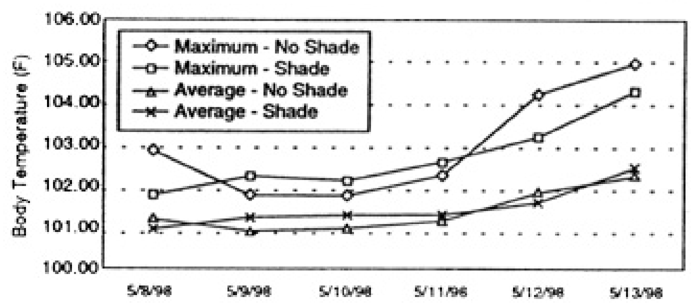


Figure 5. Average and maximum body temperature for cows on high rotation fescue/alfalfa pastures.

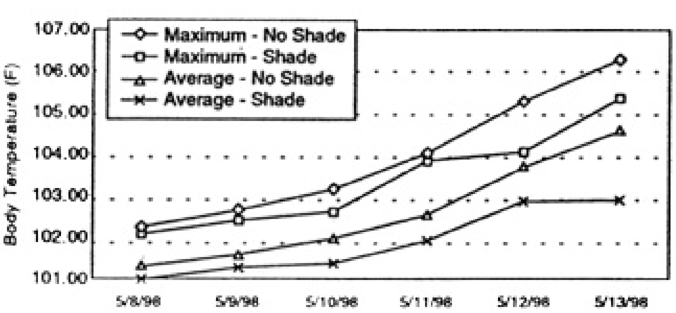


Figure 6. Average and maximum body temperature for cows on high rotation fescue pastures.

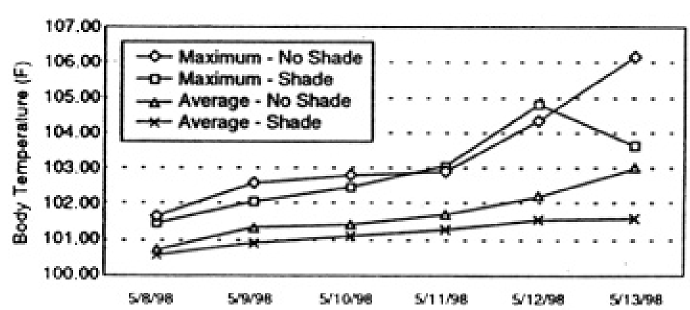


Figure 7. Diurnal range of body temperature for cows on low rotation fescue/alfalfa pastures.

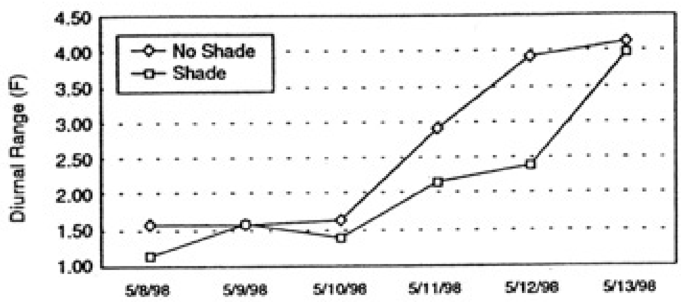


Figure 8. Diurnal range of body temperature for cows on low rotation fescue pastures.

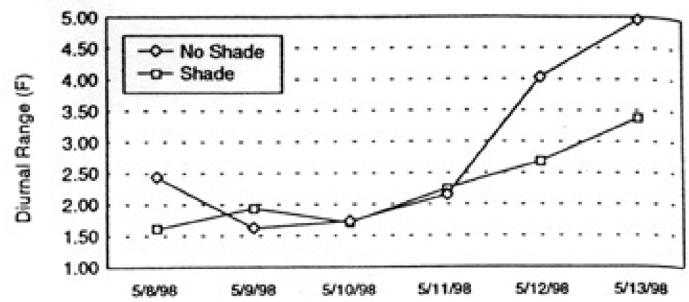


Figure 9. Diurnal range of body temperature for cows on high rotation fescue/alfalfa pastures.

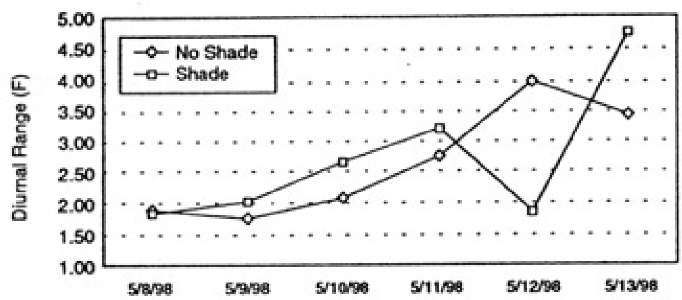


Figure 10. Diurnal range of body temperature for cows on high rotation fescue pastures.

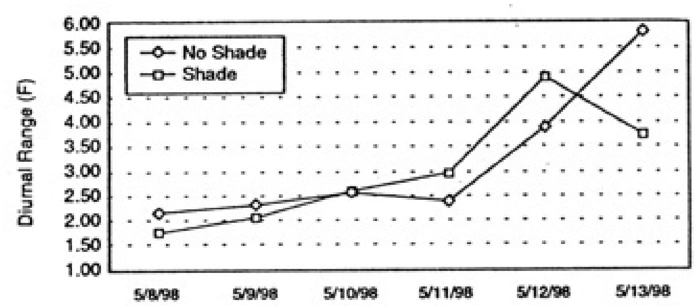
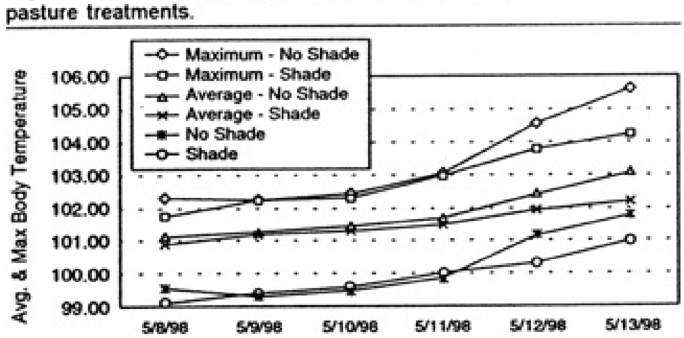
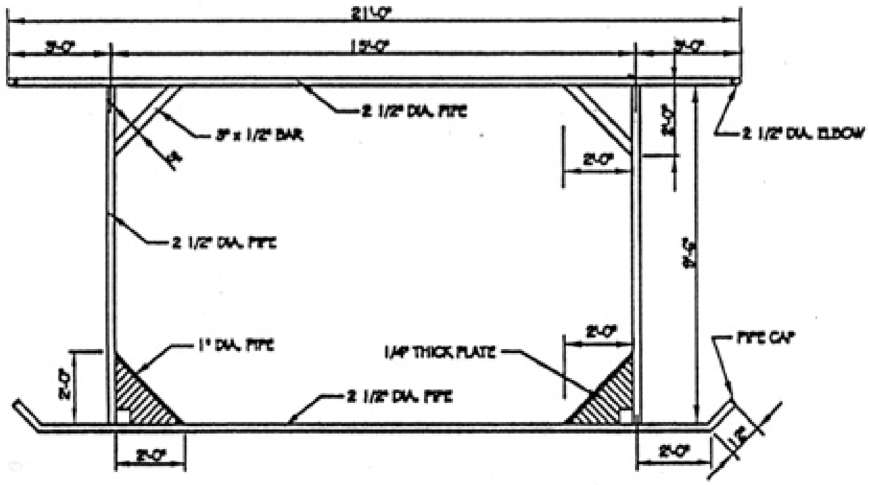
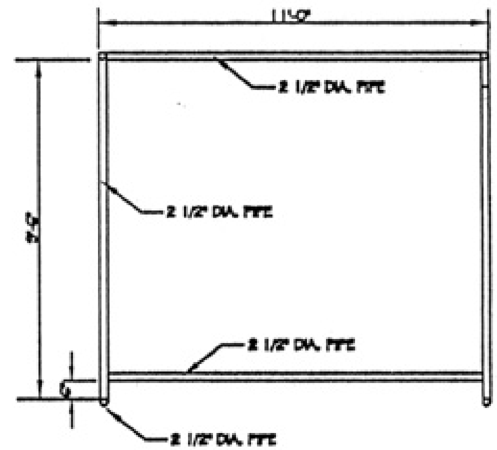


Figure 11. Summary of deep body temperature data across all pasture treatments.

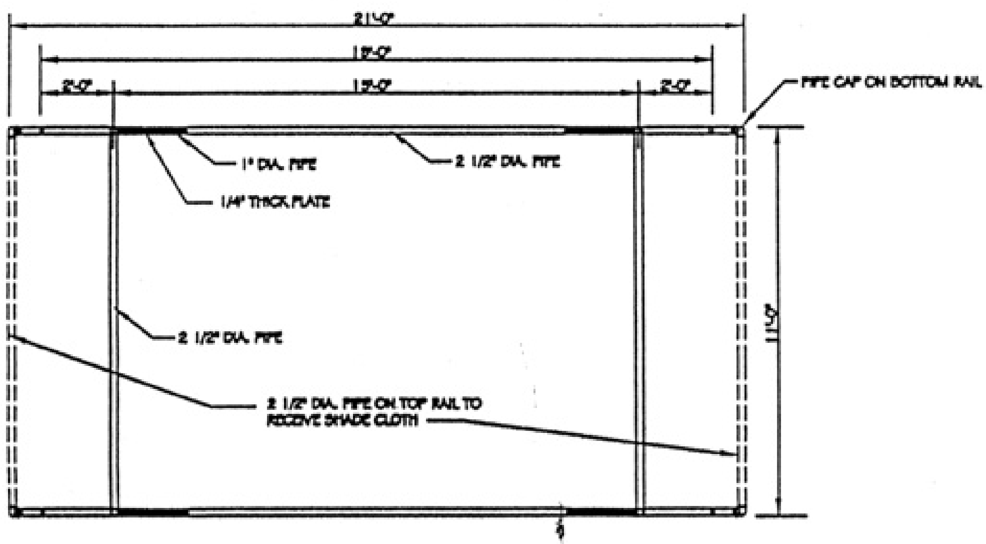




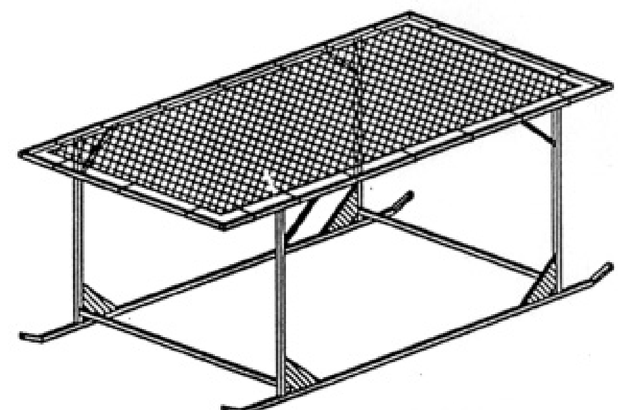
SIDE VIEW
SCALE: 3/8"=1'-0"



FRONT VIEW
SCALE: 3/8"=1'-0"



PLAN VIEW
SCALE: 3/8"=1'-0"



PERSPECTIVE VIEW

NOTES:
1. VERTICAL & LOWER HORIZONTAL 2 1/2" PIPE ENDS FLATTENED
2. 1/4" PLATE TO PREVENT COWS LEGS FROM GETTING CAUGHT UNDER PIPE PLUS MORE STABILITY.
3. OVERALL ROOF LENGTH MAY VARY ACCORDING TO WELD POSITIONING
4. PIPE ELBOWS & END CAPS ARE SCREWED ON
5. ATTACH 10' x 20', 80% SHADE CLOTH TO FRAME, WRAPPING ATTACHMENT CORD IN SPIRAL PATTERN

COOPERATIVE EXTENSION SERVICE
AGRICULTURE AND HOME ECONOMICS
DEPARTMENT OF AGRICULTURAL ENGINEERING
COLLEGE OF AGRICULTURE
UNIVERSITY OF KENTUCKY
AND
U.S. DEPARTMENT OF AGRICULTURE COOPERATING

CATTLE SHADE

Design by: L.T.	PLAN NO. KY. 11.772-16
Checked by: L.T.	
Drawn by: B.E.P.	SHEET 1 OF 1
Date: SEPT. - 96	

Shade for Grazing Cattle
Pipe Structure Materials List

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by
Terry Hutchens

Black Pipe Option*

Quantity	Item	Estimated Cost	
		$ Unit	$ Total
6	2.5", 21' black pipe	55	330
4	2.5", weld-in elbow	5	20
4	2.5", weld-in 45 joint	5	20
4	2.5", weld-in pipe cap	5	20
4	1.0", pipe with .25" plate	7	28
	TOTAL		**418**

*Black pipe requires painting for rust prevention.

Sources: Harbor Steel & Supply Corporation
1115 Delaware Avenue
Lexington, KY 40505
Phone: (606) 255-7884
(800) 766-4113

Brock McVey Company
1100 Brock McVey Drive
Lexington, KY 40509
Phone: (606) 255-1412

Galvanized Option

Quantity	Item	$ Unit	$ Total
6	2" x 4' SS20 pipe	7	56
6	2.5" x 10.6' SS40 pipe	21	126
2	2.5" x 21' SS40 pipe	42	84
3	2.0" x 21' SS40 pipe	30	90
1	Shade cloth 80% 10' x 20'	49	49
1	"Drop off charge	50	50
	SUB-TOTAL		**455**
	TAX		**28**
	TOTAL		**483**
1	Prefabricated **TOTAL**		**660**

Source: Stephens Pipe & Steel Inc.
P.O. Box 818/ HWY 619
Russell Springs, KY 42642
Phone: (502) 866-3331
(800) 451-2612

The partial list of manufacturers and dealers is furnished for your information, with the understanding that no discrimination is intended and no guarantee of reliability implied.