

EFFECT OF TEMPERATURE AND RAINFALL
ON SUMMER STEER GAINS OBTAINED ON
KANSAS BLUESTEM RANGE

by 632

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CHAPTER I

INTRODUCTION

A vegetative region is a product of its environment. A portion of this environment can be controlled through range management practices such as stocking rate adjustment, fertilization, irrigation and range burning. However, climatic conditions of environment such as temperature and rainfall cannot be controlled, therefore they must be accepted.

Even though climatic conditions cannot be controlled their effect on range conditions and cattle weight gains must be understood. Without this understanding the range manager cannot develop proper management practices. Climatic conditions prior to and during the grazing season should be considered when selecting the type and weight of cattle to stock, fixing the proper stocking rate and determining the best burning date.

It is well known that climate affects both range production and animal production, but when range production is an intermediate to animal production it can be difficult to separate the effect climate had on each individually. This interaction does exist, and should be remembered.

The purpose of this study was to determine the effect of temperature and rainfall on summer steer gains obtained on bluestem range near Manhattan, Kansas.

CHAPTER 2

REVIEW OF LITERATURE

Range Management

Hensel (1923) began burning studies on Flint Hills range in 1918. It was found that burning had no effect on forage production. However, both maximum and minimum soil temperatures averaged 3.5 to 4°F higher for the season on burned than on unburned plots, but minimum temperatures frequently were lower on burned plots than on unburned ones in March and April. Soil moisture was not measured, but it was pointed out that warmer soils would have caused early rapid plant growth and increased early use of soil moisture. This could have caused a soil moisture shortage for later growth.

Aldous (1934) observed that burned plots had higher soil temperatures than unburned ones and that the higher temperatures stimulated earlier growth. The forage yields were higher for the burned plots until mid June, after this time the unburned plots had the most forage. Measurements showed that the upper 3 feet of the burned plots were drier than on the unburned plots and it was speculated that increased runoff caused the reduction in forage yield on burned plots. In contrast to Hensel (1923), burning decreased the total forage yield for the season.

Hanks and Anderson (1957) concluded that decreased infiltration rate was one reason burned plots had less soil moisture than unburned ones. Observations showed that after an intense September rain of 4.47 inches, soil moisture in the upper 5 feet of soil increased by 4 inches on unburned plots but only 2.5 inches on burned plots.

Bieber and Anderson (1961) with the aid of aluminum access tubes and a neutron moisture gauge concluded that time of burning will affect the amount

of soil moisture. Early burned plots were found to have significantly less soil moisture when compared to unburned plots, but late spring burned plots had approximately the same soil moisture content as did unburned plots.

Anderson (1965) reported that burning reduced soil moisture regardless of burning date. Early spring burning caused the greatest reduction and the reduction was greatest in the deeper soil levels.

Forage yields appear to depend on soil moisture, which in turn depends on rainfall and time of burning. McMurphy and Anderson (1963) showed that burned plots had lower forage yields and that the lowest yields occurred during the driest seasons. Anderson (1964) summarized 30 years of burning trials on ungrazed bluestem plots at Manhattan, Kansas. The trials showed forage yields were consistently less on burned plots regardless of the time of burning. However, late spring burned plots (about May 1) yielded more than those burned earlier.

Ehrenreich and Aikman (1957) showed that burning nearly doubled bluestem production in northeastern Iowa. The three main grasses studied were big bluestem (Andropogon gerardi), little bluestem (A. scoparius) and indiangrass (Sorghastrum nutans).

Curtis and Partch (1950) in Wisconsin noted increased yields after burning big bluestem and attributed the increase to the removal of insulating cover of old stems. Dix and Butler (1954) reported increases in height and number of big bluestem flower stalks the first growing season after burning.

Kucera and Ehrenreich (1962) reported increased yields of big and little bluestem and indiangrass following burning. The increase was accredited to

higher soil temperatures, reduction in shade and greater availability of nutrients.

Hopkins, Albertson and Riegel (1948) found that burning in west-central Kansas, where the annual precipitation is less than 25 inches reduced little bluestem production greatly. Elwell, Daniel and Fenton (1941) at Guthrie, Oklahoma found that burning reduced forage yields by 40 to 60 percent.

Other than increased forage yields in areas of high rainfall, increased cattle gains in all areas regardless of rainfall is the main reason for burning. Anderson (1961) reported that over a 10 year period, late spring burning (May 1) resulted in average annual gains of 266 pounds per head, compared with 242 pounds for early spring burning (March 20) and 235 pounds on unburned range. This was confirmed by Smith et al. (1965), when it was found, that over a 15 year period beef gains on mid (April 10) and late spring (May 1) burned pastures was 20 to 23 pounds per steer higher than on adjacent, unburned pastures.

Smith et al. (1960) found that digestibility of forage was affected by burning. The protein digestibility did not seem to be greatly affected by burning. Burning increased digestibility of ether extract, crude fiber and dry matter.

Neal and Becker (1933) and Greene (1935) found that the ash and protein content of forages was increased by burning. This was confirmed by Smith and Young (1959).

Hitchcock and Westgate (1901) reported stocking rates of $1\frac{1}{2}$ to 3 acres per animal in the Flint Hills of Kansas. From this early date to the present stocking rates have declined which indicates two things: (1) that

depletion has required reduced stocking rates (2) that range productivity was over-rated at first, hence, stocking was too heavy.

In 1925, when the Kansas State Board of Agriculture began annual reporting of stocking rates in the Flint Hills allowances averaged around $3\frac{1}{4}$ acres per yearling and about $4\frac{1}{3}$ for older steers and cows (Kansas State Board of Agriculture, 1957, 1965). During the drought of the 1930's, the allowance increased to $4\frac{1}{2}$ acres per yearling. Average allowances in 1965 were 3.8 acres per yearling.

Smith et al. (1963) showed that a stocking rate of 3.3 acres per yearling steer gave an gain of 232 pounds while rates of 1.8 and 4.6 acres per steer gave only 177 and 215 pounds of gain, respectively. The overstocked rate (1.8 acres per steer) gave the best gains per acre, but it also caused a lowering of range condition.

Studies in Colorado by Hanson, Love, and Morris (1931) showed that 9 years of deferred-rotation grazing resulted in a 53 percent increase in density of vegetation, while the total number of undesirable plants actually decreased 18 percent.

Herbel and Anderson (1959) reported lower utilization of pastures being deferred-rotated than for moderately stocked pastures, despite the fact that they had been stocked at the same rate.

Temperature

Worstell and Brody (1953) suggested a more urgent need for developing methods for protecting cattle against rising temperatures above 80°F than against declining temperatures below freezing. Angus yearling steers grazing pastures with natural or artificial shade made significantly better

gains than steers on pasture without shade.

Dice (1935) established that dairy cows can withstand long periods of exposure to temperatures as low as 0°F with little loss in production or feed efficiency. However, temperatures in excess of 85°F had detrimental effects (Rhoad, 1936).

At 80 to 85°F dairy cows reach a point where they are no longer able to maintain heat balance (Regan and Richardson, 1938). Twelve high producing dairy cows were observed in a large psychrometric room in which the temperature was increased from 40 to 100°F while air movement and relative humidity remained constant. It was found that respiration rate approximately doubled for each 18°F increase in the room temperature. At temperatures above 80 to 85°F depending upon the breed of cow, anorexia developed and milk flow declined.

Hereford and Angus cows on pastures with natural shade gained significantly more than cows on pastures with no shade (McDaniel and Roark, 1956). However, cows on pastures with artificial shade did not gain significantly more than the cows without shade. Observations showed that cows on pastures with either type of shade spent more time grazing and less time standing than cows with no shade. Calf gains were significantly improved by shade regardless of kind or amount.

Casady, Legates and Myers (1956) found indications that thermoregulation in young animals is not as efficient as in the adult. Four Holstein bulls approximately 18 months old were subjected to continuous air temperatures of 60, 70, 80, 85, 90 and 95°F in environmental chambers for 29 to 50 days in duration. The bulls continued to gain until exposure to temperatures of 70 to 80°F. These same bulls were exposed to identical conditions at 30

months of age, however a loss of weight was not observed until temperatures over 90°F.

Heat tolerance, as measured by physiological responses to atmospheric conditions, was observed both in a heat chamber and under natural field conditions during the summer (Cartwright, 1955). A total of 366 cattle was observed including bulls, heifers, and steers, principally of Hereford and Brahman breeds and the cross (F₁) between these breeds. Observations of heat tolerance showed that the F₁ group was close to, or identical with, the more heat tolerant parent, the Brahman. This suggested that heat tolerance of the Brahman might be partially dominant. Results showed that summer gain was more useful in selection for heat tolerance than any other measure studied.

Mullick, Murty and Kehar (1952) observed the pulse rate, respiration rate, body temperature and body weight on six kumauni hill steers for summer, autumn, winter and spring seasons over a period of 18 months. The pulse rate, respiration rate and body temperature increased while body weight decreased in the summer months (mean temperature 98°F). The ratio of water intake to dry matter intake was maximum during the summer, 5 to 1, and minimum during winter, 6 to 4.

Gaztambide Arrillaga, Henning and Miller (1952) observed European breeds of cattle on farms in Puerto Rico and found no significant affect of environmental temperatures prevalent during a two year period on body temperature, respiratory rate, pulse rate or blood hemoglobin. Contrary to the behavior of European dairy breeds, the beef cattle of European breeding appeared to be affected by air humidity.

In a review of environmental effects on growth (Winchester, 1964) described a negative linear relationship between food intake and ambient temperatures. Water consumption increased with rising temperatures but may decrease in the 90 to 100°F range with a decrease in food intake. Water intake of cattle was directly related to ambient temperature and dry matter consumption. The review suggested that the severest stress experienced by mammals may not be after puberty, but that experienced during prenatal and early postnatal life.

The heat tolerances for certain breeds and crossbred types were determined by Rhoad, 1942 as follows: Purebred Brahman 93, $\frac{1}{2}$ Brahman $\frac{1}{2}$ Angus 89, purebred Jersey 86, $\frac{3}{8}$ Brahman $\frac{5}{8}$ Angus 86, purebred Santa Gertrudis 82, $\frac{1}{4}$ Brahman $\frac{3}{4}$ Angus 76, grade Hereford 73 and purebred Angus 56. These figures were determined by the following formula developed at the Iberia Livestock Experiment Farm: $100 - 10(BT - 101.0)$, in which BT = body temperature obtained under conditions of 90°F, 101.0 = normal body temperature for cattle, 10 = a factor to convert degrees deviation in body temperature from the normal to a unit basis and 100 = perfect efficiency in maintaining body temperature at 101.0°F.

Gaztambide Arrillaga (1949) observed five dairy and three beef breeds of cattle at 85°F and found the average body temperature of the five dairy breeds was 102.09°F as compared to 101.5°F considered to be normal. The respiratory rate for the dairy breeds was 52.7 as compared to 22 respirations per minute considered to be normal. The pulse rate in the dairy breeds was 45.9 as compared to 45 beats per minute for the normal. The dairy breeds had lowered blood hemoglobin content, 70.7 as compared to 125 grams hemoglobin per 100 milligrams of blood for the normal. The beef breeds when

compared to the dairy breeds showed greater variation from the normal in all measurements.

Darlow et al. (1949) bled 10 cows and five heifer calves of each of three breeds (Angus, Shorthorn and Hereford) at monthly intervals over a 2 year period to study the levels of several blood constituents. Considerable seasonal variation in plasma carotene was observed; levels below 75 mcg per 100 ml of plasma were observed during the winter months and levels as high as 1200 mcg per 100 ml were observed during the summer months. Low levels of ascorbic acid were found during August, September and February which were the months of extremes in temperature.

Weldy et al. (1964) observed that Holstein cows and yearling Hereford heifers in psychrometric chamber at 90°F had a lower total VFA concentrations in the rumen than at lower temperatures. Lower acetic acid concentrations were largely responsible for this reduction. A significant positive correlation was found between total VFA concentrations and rectal temperature, but the relationships of VFA levels to dry matter and water intake, blood glucose and blood ketones were quite variable. An explanation may be that the rumen organisms themselves are affected by ambient temperature as suggested by Brody (1956).

Conrad (1966) in a review of factors limiting feed intake found that the hypothalamus contained a thermosensitive area which responded to thermal gradients. Cooling in the preoptic areas of the hypothalamus increased feed intake in goats. When other areas of the hypothalamus were warmed, eating stopped. At a critical temperature feed intake declined to a level too low to support normal production. The critical temperature was dependent on calorigenic effect of the diet, net energy of production

and characteristics of various breeds and species.

Rainfall

Launchbaugh (1957) at Fort Hays Experiment Station correlated precipitation with animal gains over an 11 year trial. Precipitation was highly correlated with forage yield, but there did not seem to be a corresponding correlation between precipitation and animal gains. During the first four years precipitation and gains appeared to be related, however, 1951, the wettest year of the trial, gains were 14 pounds below average. During the 2 following drought years, gains were well above the average. He concluded this indicates that forage quality is equally as important as forage quantity in producing livestock gains and dry years often produce excellent quality forage though total production may be low.

Observations made on buffaloes at Izatnagar and on hill-bulls and sheep at Mukteswar showed that natural rainfall lowered body temperature by a significant amount in nearly every observation (Minett, 1947). The buffaloes were observed at an approximate 80°F air temperature before the rain and experienced a 1.00 to 2.58°F drop in body temperature following the rain. The sheep and hill-bulls were observed at temperatures ranging from 60 to 75°F and experienced up to 3.87°F lowered body temperatures with the maximum fall in body temperatures 6 hours after the rain.

Launchbaugh (1967) found as in 1957, that precipitation was not correlated with animal gains, however the large yearly variations in total herbage production in western Kansas were related to annual fluctuations in precipitation. Precipitation from the previous year plus January through April of the current year accounted for a nonsignificant 10.9% of the

variation in total herbage production. Precipitation from October of the previous year through April of the current year accounted for 43.6% of the variation which was highly significant. Precipitation during the current year was highly significant with the total yield and accounted for 70.6% of the variation. Precipitation during the growing season was the major factor in total herbage yield which is in agreement with Clarke, Tisdale and Skoglund (1947).

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Chapter 3

EFFECT OF TEMPERATURE AND RAINFALL ON SUMMER STEER GAINS OBTAINED ON KANSAS BLUESTEM PASTURE

Temperatures of 85°F and higher are detrimental to cattle performance (Rhoad, 1936). At 80 to 85°F dairy cows reach a point where they are no longer able to maintain heat balance resulting in anoxeria and lower milk production (Regan and Richardson, 1938). Increased body temperature, increased respiratory rate, increased pulse rate and lowered blood hemoglobin have been demonstrated by Gaztambide Arrillaga (1949) in heat stressed cattle. Weldy et al. (1964) found that heat stress lowered total rumen VFA concentration with lower acetic acid concentration largely responsible. Brody (1956) suggested that the rumen organism population might be affected by ambient temperature.

Worstell and Brody (1953) found that natural and artificial shade protected cattle against temperatures above 80°F. Shaded cattle made significantly higher gains than cattle on pastures without shade which is in agreement with McDaniel and Roark (1956).

Conrad (1966) reviewed the factors affecting feed intake and found that the hypothalamus contain a thermosensitive area which responded to ambient temperatures. Cooling in the preoptic area of the hypothalamus increased feed intake, while warming other areas of the hypothalamus lowered feed intake.

Launchbaugh (1957, 1967) attempted to correlate rainfall with cattle gains. Results indicate that rainfall was highly correlated with forage yield, but there was not a corresponding correlation with cattle gains.

The purpose of this study was to correlate steer gains obtained on Kansas bluestem pasture with existing temperature and rainfall conditions.

EXPERIMENTAL PROCEDURE

From 1950 through 1965, 2129 Hereford steers of high good to low choice feeder grades were observed on bluestem pasture management trials. These trials were conducted at the Experimental Range Unit located 8.1 km northwest of Manhattan, Kansas. An average of 133 steers were randomly allotted to nine pastures on approximately May 1 of each year and removed on approximately October 1 of the same year.

Three of the pastures were grazed season-long at different stocking rates; moderate-stocked, over-stocked and under-stocked. During the 16 years these rates varied from 1.3 to 2.0, 0.7 to 1.4, 1.9 to 3.0 hectares per steer, respectively. Three of the pastures were on a deferred rotation plan stocked at the moderate rate. In this plan all of the animals were placed on two of the pastures on approximately May 1 and left until approximately July 1 at which time all the steers were shifted to the deferred pasture. The deferred pasture was rotated among the three pastures annually. If at a later date the grass on the deferred pasture became short the steers were allowed to graze all three pastures for the remainder of the season. Three of the pastures were used for date of burning studies and were stocked at the moderate rate. One pasture was early-spring burned varying from February 26 to April 7, another mid-spring burned varied from April 1 to April 13, the third, late-spring burned varied from April 24 to May 4.

The steers were gathered in the afternoon on approximately the first of each month, held overnight without feed or water and weighed the following morning.

Initial and final weights were obtained after putting all the steers together and weighing them in random order.

Statistical Analysis

Each month of the grazing season was analyzed separately by correlating that month's 16 year average steer gain with temperature (mean, mean maximum and mean minimum) and rainfall averages of that month and the previous 5 months. Temperature and rainfall measurements of the previous 5 months were added 1 month at a time, resulting in the average of 2, 3, 4, 5 and 6 months temperature and the total of 2, 3, 4, 5 and 6 months rainfall measurements being correlated with the average steer gain for that month. Each of the climatic variables were analyzed for quadratic and linear effects.

RESULTS

May Analysis

None of the climatic conditions tested were highly correlated with May steer gain. The total rainfall for May plus the previous 4 months (January, February, March, April and May) showed the highest correlation with May gain (0.230). The quadratic of the mean maximum temperature for December through March had the highest temperature correlation with May gain but this correlation was only 0.084.

There was a trend for the quadratic of the temperature and rainfall conditions to have higher correlations with weight gain than did the linear of the same conditions.

June Analysis

The quadratic of February through April mean maximum temperature had the highest correlation with June weight gain (-0.294). This negative correlation would have to be explained by an effect on the forage because the steers were not yet purchased during these months.

The February through June mean temperature was correlated -0.292 with June steer gain. It would appear that this is mainly due to effects on the forage. If the main effect had been on the steers, the May through June mean temperatures would have had the highest correlation, but this correlation was only -0.088.

The rainfall variables had very low correlations with steer gain. The highest correlation was only 0.055.

July Analysis

The March through May mean maximum temperature had the greatest effect of all the factors studied on July steer gain with a correlation of 0.280. The mean temperature of March through July was the next largest contributor with a correlation of 0.186. Both of these climatic conditions were quadratic in effect.

The mean maximum temperature over the 16 years during March through May was only 19.2°C which may explain why the correlation between this temperature and July steer gain was positive. According to Rhoad (1936), temperatures below 29.4°C have no detrimental effect on cattle performance until approaching -17.8°C.

March through July total rainfall was negatively correlated with July weight gain -0.126.

August Analysis

April through June mean maximum temperature (25.2°C) and August steer gain had a correlation of -0.382 . Part of this negative correlation might be that the steers were approaching exposure to the critical temperature (29.4°C). Part might be explained by the effect of high temperature on forage production and soil moisture.

The June through August mean minimum temperature and August gains had a correlation of -0.270 , while the April through August mean temperature and August gain had a correlation of -0.327 .

March through August total rainfall had a correlation with August gain of 0.316 .

September Analysis

The correlation between September gain and the quadratic of April through September mean minimum temperature was -0.152 . This was the highest correlation obtained between September gain and the climatic conditions studied. The quadratic of June through July mean maximum temperature had a correlation of only 0.094 with the September gain.

August through September total rainfall had a correlation of 0.147 with September steer gain.

DISCUSSION AND CONCLUSIONS

The low correlations between the temperature conditions previous to and during May and May weight gain could be explained by the fact that the steers were only exposed to these conditions during May. The steers during the 16 years were purchased from various sections of the United States and

some were not exposed to eastern Kansas climate until May of each year. The rainfall, 4 months previous to and during May, was correlated with May gain (0.230). This correlation had to be due to the preseason rainfall effect on forage production and the forage production influencing steer gain.

Rainfall had a low correlation with June steer gain. Low correlations between rainfall and weight gain is in agreement with Launchbaugh (1957).

Rainfall was found to be negatively correlated with July weight gain (-0.126). June and July are the months having the highest rainfall. An explanation for this negative correlation is that in months of high precipitation and lush forage production, forage protein intake is lower per unit of dry matter despite selective grazing by steers (Launchbaugh and Brethour, 1968).

In conclusion, the mean maximum temperature was the temperature measurement that had the highest correlation with each months steer gain. Results indicated that the environmental conditions during and 4 months previous to each months gain had a higher correlation with that gain than any of the other monthly climatic combinations.

The environmental conditions existing prior to the grazing season appeared to have the major effect on steer gains, since the previous 4 months climatic conditions had the highest correlation with that months gain. This would indicate that the climatic effect on gain was through climatic effects on forage production and quality.

Temperature, regardless of type of measurement, mean, mean maximum or mean minimum, tended toward a quadratic relationship with steer weight gain; while the relationship between rainfall and steer weight gain was linear.

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APPENDICES

APPENDIX A
CORRELATIONS BETWEEN FACTORS AFFECTING MAY STEER GAIN

	1	2	3	4	5	6	7	8	9	10
(1) May Avg Steer Wt	1.000									
(2) March Avg Max Temp	-0.135	1.000								
(3) (March Avg Max Temp) ²	-0.098	0.998	1.000							
(4) Feb-March Avg Max Temp	-0.384	0.830	0.810	1.000						
(5) (Feb-March Avg Max Temp) ²	-0.364	0.818	0.800	0.998	1.000					
(6) Jan-March Avg Max Temp	-0.449	0.603	0.471	0.869	0.864	1.000				
(7) (Jan-March Avg Max Temp) ²	-0.441	0.584	0.554	0.860	0.856	0.999	1.000			
(8) Dec-March Avg Max Temp	-0.297	0.485	0.460	0.769	0.776	0.892	0.896	1.000		
(9) (Dec-March Avg Max Temp) ²	-0.302	0.476	0.451	0.769	0.777	0.892	0.896	0.999	1.000	
(10) April-May Avg Min Temp	0.190	0.066	0.075	-0.177	-0.186	-0.251	-0.259	-0.392	-0.393	1.000
(11) (April-May Avg Min Temp) ²	0.185	0.066	0.075	-0.174	-0.184	-0.240	-0.248	-0.386	-0.387	0.999
(12) March-May Avg Min Temp	0.057	0.636	0.642	0.335	0.323	0.119	0.102	-0.029	-0.036	0.725
(13) (March-May Avg Min Temp) ²	0.064	0.633	0.640	0.332	0.320	0.113	0.097	-0.034	-0.041	0.726

APPENDIX A-1

	1	2	3	4	5	6	7	8	9	10
(14) Feb-May Avg Min Temp	-0.287	0.766	0.754	0.691	0.680	0.482	0.467	0.310	0.309	0.416
(15) (Feb-May Avg Min Temp) ²	-0.277	0.760	0.749	0.683	0.673	0.469	0.454	0.298	0.297	0.425
(16) Jan-May Avg Min Temp	-0.264	0.601	0.580	0.555	0.541	0.552	0.543	0.368	0.366	0.495
(17) (Jan-May Avg Min Temp) ²	-0.256	0.591	0.571	0.544	0.531	0.545	0.538	0.361	0.359	0.504
(18) Dec-May Avg Min Temp	-0.031	0.445	0.445	0.346	0.353	0.275	0.274	0.318	0.319	0.465
(19) (Dec-May Avg Min Temp) ²	-0.030	0.444	0.444	0.347	0.354	0.275	0.274	0.322	0.322	0.465
(20) April-May Mean Temp	0.242	0.013	0.025	-0.217	-0.223	-0.285	-0.290	-0.449	-0.446	0.923
(21) (April-May Mean Temp) ²	0.236	0.014	0.025	-0.217	-0.223	-0.281	-0.286	-0.447	-0.444	0.924
(22) March-May Mean Temp	0.091	0.686	0.694	0.388	0.377	0.170	0.154	-0.022	-0.026	0.712
(23) (March-May Mean Temp) ²	0.099	0.684	0.692	0.383	0.371	0.163	0.147	-0.029	-0.033	0.714
(24) Feb-May Mean Temp	-0.249	0.809	0.797	0.796	0.789	0.607	0.594	0.406	0.408	0.385
(25) (Feb-May Mean Temp) ²	-0.238	0.804	0.793	0.791	0.785	0.598	0.586	0.399	0.401	0.393
(26) Jan-May Mean Temp	-0.298	0.633	0.609	0.703	0.692	0.762	0.757	0.546	0.547	0.362

APPENDIX A-2

	1	2	3	4	5	6	7	8	9	10
(27) (Jan-May Mean Temp) ²	-0.290	0.623	0.600	0.694	0.684	0.758	0.754	0.543	0.544	0.370
(28) Dec-May Mean Temp	-0.104	0.546	0.536	0.584	0.590	0.601	0.601	0.608	0.610	0.359
(29) (Dec-May Mean Temp) ²	-0.102	0.541	0.531	0.581	0.580	0.599	0.600	0.609	0.612	0.361
(30) April-May Total Rain	-0.477	0.183	0.160	0.195	0.177	0.261	0.259	0.240	0.241	-0.310
(31) (April-May Total Rain) ²	-0.446	0.179	0.158	0.159	0.139	0.215	0.209	0.200	0.198	-0.299
(32) March-May Total Rain	-0.522	0.079	0.055	0.114	0.093	0.189	0.183	0.160	0.158	-0.329
(33) (March-May Total Rain) ²	-0.497	0.100	0.077	0.112	0.090	0.177	0.169	0.154	0.150	-0.353
(34) Feb-May Total Rain	-0.479	-0.048	-0.070	-0.001	-0.016	0.106	0.106	0.124	0.126	-0.294
(35) (Feb-May Total Rain) ²	-0.451	0.004	-0.016	0.022	0.005	0.110	0.107	0.125	0.125	-0.326
(36) Jan-May Total Rain	-0.422	-0.147	-0.166	-0.158	-0.174	-0.044	-0.045	-0.012	-0.010	-0.179
(37) (Jan-May Total Rain) ²	-0.397	-0.081	-0.098	-0.120	-0.138	-0.032	-0.036	-0.001	-0.001	-0.217
(38) Dec-May Total Rain	-0.445	-0.161	-0.182	-0.144	-0.158	-0.021	-0.020	0.020	0.024	-0.216
(39) (Dec-May Total Rain) ²	-0.427	-0.085	-0.104	-0.100	-0.116	-0.002	-0.005	0.034	0.035	-0.256
(40) May Avg Gain	-0.162	-0.065	-0.068	0.023	0.024	0.015	0.017	0.081	0.084	0.082

APPENDIX A-3

	11	12	13	14	15	16	17	18	19	20
(11) (April-May Avg Min Temp) ²	1.000									
(12) March-May Avg Min Temp	0.724	1.000								
(13) (March-May Avg Min Temp) ²	0.726	0.999	1.000							
(14) Feb-May Avg Min Temp	0.417	0.857	0.855	1.000						
(15) (Feb-May Avg Min Temp) ²	0.426	0.862	0.860	0.999	1.000					
(16) Jan-May Avg Min Temp	0.501	0.793	0.788	0.889	0.885	1.000				
(17) (Jan-May Avg Min Temp) ²	0.511	0.792	0.786	0.883	0.880	0.999	1.000			
(18) Dec-May Avg Min Temp	0.465	0.754	0.749	0.755	0.758	0.813	0.812	1.000		
(19) (Dec-May Avg Min Temp) ²	0.465	0.753	0.748	0.755	0.757	0.813	0.812	0.999	1.000	
(20) April-May Mean Temp	0.923	0.590	0.591	0.290	0.296	0.368	0.374	0.335	0.332	1.000
(21) (April-May Mean Temp) ²	0.924	0.591	0.591	0.292	0.297	0.372	0.378	0.335	0.332	0.999
(22) March-May Mean Temp	0.712	0.911	0.910	0.778	0.779	0.714	0.710	0.616	0.613	0.720
(23) (March-May Mean Temp) ²	0.714	0.910	0.910	0.774	0.775	0.707	0.704	0.611	0.608	0.722

APPENDIX A-4

	11	12	13	14	15	16	17	18	19	20
(24) Feb-May Mean Temp	0.388	0.742	0.739	0.908	0.904	0.809	0.801	0.614	0.612	0.383
(25) (Feb-May Mean Temp) ²	0.395	0.744	0.742	0.907	0.904	0.806	0.798	0.617	0.615	0.391
(26) Jan-May Mean Temp	0.372	0.588	0.582	0.756	0.746	0.875	0.872	0.603	0.601	0.366
(27) (Jan-May Mean Temp) ²	0.380	0.586	0.580	0.750	0.741	0.875	0.873	0.605	0.603	0.374
(28) Dec-May Mean Temp	0.364	0.587	0.582	0.690	0.685	0.792	0.788	0.842	0.841	0.348
(29) (Dec-May Mean Temp) ²	0.365	0.583	0.577	0.685	0.680	0.788	0.784	0.839	0.839	0.349
(30) April-May Total Rain	-0.310	-0.097	-0.099	0.089	0.086	0.051	0.052	-0.132	-0.128	-0.470
(31) (April-May Total Rain) ²	-0.230	-0.095	-0.097	0.057	0.053	-0.008	-0.008	-0.175	-0.171	-0.470
(32) March-May Total Rain	-0.326	-0.103	-0.103	0.093	0.091	0.045	0.045	-0.098	-0.094	-0.526
(33) (March-May Total Rain) ²	-0.351	-0.125	-0.126	0.058	0.055	-0.017	-0.018	-0.153	-0.149	-0.546
(34) Feb-May Total Rain	-0.293	-0.172	-0.173	-0.012	-0.014	-0.030	-0.029	-0.112	-0.108	-0.468
(35) (Feb-May Total Rain) ²	-0.326	-0.183	-0.184	-0.031	-0.033	-0.086	-0.086	-0.175	-0.171	-0.498
(36) Jan-May Total Rain	-0.178	-0.152	-0.154	-0.078	-0.079	-0.071	-0.069	-0.106	-0.103	-0.348

APPENDIX A-5

	11	12	13	14	15	16	17	18	19	20
(37) (Jan-May Total Rain) ²	-0.218	-0.161	-0.163	-0.088	-0.090	-0.123	-0.122	-0.170	-0.167	-0.386
(38) Dec-May Total Rain	-0.215	-0.171	-0.175	-0.079	-0.081	-0.069	-0.069	-0.089	-0.086	-0.376
(39) (Dec-May Total Rain) ²	-0.256	-0.168	-0.172	-0.075	-0.077	-0.108	-0.109	-0.135	-0.132	-0.414
(40) May Avg Gain	0.083	-0.016	-0.009	0.011	0.016	-0.020	-0.017	0.039	0.043	0.013

APPENDIX A-6

	21	22	23	24	25	26	27	28	29	30
(21) (April-May Mean Temp) ²	1.000									
(22) March-May Mean Temp	0.720	1.000								
(23) (March-May Mean Temp) ²	0.723	0.999	1.000							
(24) Feb-May Mean Temp	0.384	0.829	0.825	1.000						
(25) (Feb-May Mean Temp) ²	0.392	0.832	0.828	0.999	1.000					
(26) Jan-May Mean Temp	0.371	0.683	0.676	0.877	0.873	1.000				
(27) (Jan-May Mean Temp) ²	0.378	0.680	0.674	0.871	0.868	0.999	1.000			
(28) Dec-May Mean Temp	0.348	0.633	0.627	0.766	0.766	0.848	0.849	1.000		
(29) (Dec-May Mean Temp) ²	0.350	0.629	0.624	0.762	0.763	0.845	0.847	0.999	1.000	
(30) April-May Total Rain	-0.465	-0.225	-0.225	-0.067	-0.074	-0.037	-0.038	-0.165	-0.162	1.000
(31) (April-May Total Rain) ²	-0.464	-0.230	-0.229	-0.104	-0.112	-0.093	-0.096	-0.216	-0.213	0.982
(32) March-May Total Rain	-0.519	-0.308	-0.308	-0.142	-0.150	-0.117	-0.120	-0.233	-0.232	0.946
(33) (March-May Total Rain) ²	-0.539	-0.317	-0.316	-0.164	-0.173	-0.156	-0.161	-0.272	-0.271	0.931

APPENDIX A-7

	21	22	23	24	25	26	27	28	29	30
(34) Feb-May Total Rain	-0.462	-0.359	-0.358	-0.228	-0.234	-0.174	-0.175	-0.230	-0.228	0.945
(35) (Feb-May Total Rain) ²	-0.492	-0.354	-0.354	-0.233	-0.239	-0.205	-0.207	-0.273	-0.271	0.945
(36) Jan-May Total Rain	-0.341	-0.339	-0.338	-0.304	-0.310	-0.242	-0.243	-0.262	-0.258	0.890
(37) (Jan-May Total Rain) ²	-0.379	-0.332	-0.330	-0.299	-0.305	-0.270	-0.271	-0.303	-0.300	0.904
(38) Dec-May Total Rain	-0.368	-0.361	-0.362	-0.303	-0.309	-0.233	-0.234	-0.242	-0.239	0.874
(39) (Dec-May Total Rain) ²	-0.407	-0.344	-0.345	-0.289	-0.295	-0.251	-0.254	-0.271	-0.269	0.893
(40) May Avg Gain	0.014	-0.054	-0.051	-0.002	0.000	-0.018	-0.016	0.052	0.057	0.180

APPENDIX A-8

	31	32	33	34	35	36	37	38	39	40
(31) (April-May Total Rain) ²	1.000									
(32) March-May Total Rain	0.944	1.000								
(33) (March-May Total Rain) ²	0.957	0.985	1.000							
(34) Feb-May Total Rain	0.940	0.972	0.954	1.000						
(35) (Feb-May Total Rain) ²	0.963	0.965	0.979	0.982	1.000					
(36) Jan-May Total Rain	0.894	0.923	0.905	0.978	0.954	1.000				
(37) (Jan-May Total Rain) ²	0.933	0.930	0.940	0.972	0.981	0.983	1.000			
(38) Dec-May Total Rain	0.872	0.906	0.885	0.971	0.940	0.990	0.966	1.000		
(39) (Dec-May Total Rain) ²	0.914	0.922	0.928	0.973	0.974	0.981	0.989	0.984	1.000	
(40) May Avg Gain	0.154	0.181	0.144	0.211	0.170	0.230	0.196	0.216	0.181	1.000

APPENDIX B
CORRELATIONS BETWEEN FACTORS AFFECTING JUNE STEER GAIN

	1	2	3	4	5	6	7	8	9	10
(1) June Avg Steer Wt	1.000									
(2) April Avg Max Temp	0.265	1.000								
(3) (April Avg Max Temp) ²	0.264	0.999	1.000							
(4) March-April Avg Max Temp	0.041	0.635	0.636	1.000						
(5) (March-April Avg Max Temp) ²	0.059	0.642	0.644	0.999	1.000					
(6) Feb-April Avg Max Temp	-0.228	0.419	0.424	0.849	0.843	1.000				
(7) (Feb-April Avg Max Temp) ²	-0.213	0.436	0.442	0.847	0.841	0.999	1.000			
(8) Jan-April Avg Max Temp	-0.307	0.359	0.366	0.665	0.656	0.887	0.884	1.000		
(9) (Jan-April Avg Max Temp) ²	-0.300	0.372	0.378	0.661	0.652	0.885	0.883	0.999	1.000	
(10) May-June Avg Min Temp	-0.062	0.230	0.209	0.380	0.370	0.256	0.239	0.147	0.134	1.000
(11) (May-June Avg Min Temp) ²	-0.064	0.229	0.208	0.380	0.370	0.256	0.239	0.146	0.133	0.999
(12) April-June Avg Min Temp	0.154	0.683	0.672	0.558	0.556	0.357	0.357	0.249	0.249	0.754
(13) (April-June Avg Min Temp) ²	0.154	0.680	0.669	0.558	0.556	0.357	0.357	0.250	0.250	0.753

APPENDIX B-1

	1	2	3	4	5	6	7	8	9	10
(14) March-June Avg Min Temp	0.005	0.410	0.399	0.770	0.764	0.625	0.616	0.422	0.413	0.709
(15) (March-June Avg Min Temp) ²	0.016	0.407	0.397	0.767	0.762	0.621	0.613	0.414	0.406	0.707
(16) Feb-June Avg Min Temp	-0.284	0.244	0.237	0.727	0.716	0.796	0.787	0.621	0.613	0.576
(17) (Feb-June Avg Min Temp) ²	-0.274	0.247	0.240	0.727	0.716	0.794	0.785	0.614	0.606	0.575
(18) Jan-June Avg Min Temp	-0.275	0.280	0.272	0.641	0.628	0.714	0.704	0.702	0.696	0.591
(19) (Jan-June Avg Min Temp) ²	-0.269	0.280	0.272	0.638	0.625	0.711	0.701	0.700	0.696	0.591
(20) May-June Mean Temp	-0.048	0.168	0.147	0.262	0.253	0.180	0.165	0.105	0.093	0.934
(21) (May-June Mean Temp) ²	-0.053	0.163	0.142	0.260	0.252	0.180	0.165	0.104	0.093	0.934
(22) April-June Mean Temp	0.155	0.734	0.720	0.560	0.559	0.367	0.369	0.276	0.276	0.794
(23) (April-June Mean Temp) ²	0.153	0.735	0.720	0.562	0.561	0.369	0.370	0.278	0.278	0.796
(24) March-June Mean Temp	0.011	0.515	0.504	0.860	0.855	0.710	0.701	0.520	0.510	0.768
(25) (March-June Mean Temp) ²	0.019	0.514	0.504	0.861	0.856	0.709	0.700	0.515	0.506	0.768
(26) Feb-June Mean Temp	-0.254	0.352	0.347	0.802	0.792	0.900	0.893	0.755	0.748	0.607

APPENDIX B-2

	1	2	3	4	5	6	7	8	9	10
(27) (Feb-June Mean Temp) ²	-0.246	0.358	0.352	0.804	0.794	0.902	0.894	0.753	0.746	0.606
(28) Jan-June Mean Temp	-0.300	0.346	0.341	0.684	0.672	0.828	0.819	0.875	0.870	0.556
(29) (Jan-June Mean Temp) ²	-0.295	0.349	0.344	0.681	0.669	0.827	0.818	0.876	0.871	0.554
(30) May-June Total Rain	-0.310	-0.307	-0.292	-0.340	-0.344	-0.294	-0.297	-0.224	-0.225	-0.366
(31) (May-June Total Rain) ²	-0.278	-0.368	-0.351	-0.385	-0.385	-0.310	-0.314	-0.235	-0.238	-0.371
(32) April-June Total Rain	-0.315	-0.342	-0.325	-0.382	-0.385	-0.307	-0.311	-0.177	-0.177	-0.444
(33) (April-June Total Rain) ²	-0.274	-0.395	-0.377	-0.396	-0.396	-0.305	-0.309	-0.194	-0.196	-0.440
(34) March-June Total Rain	-0.357	-0.422	-0.408	-0.449	-0.453	-0.353	-0.360	-0.225	-0.227	-0.420
(35) (March-June Total Rain) ²	-0.312	-0.461	-0.445	-0.442	-0.444	-0.341	-0.348	-0.232	-0.235	-0.433
(36) Feb-June Total Rain	-0.314	-0.336	-0.320	-0.450	-0.452	-0.374	-0.376	-0.234	-0.232	-0.474
(37) (Feb-June Total Rain) ²	-0.281	-0.391	-0.373	-0.446	-0.446	-0.360	-0.363	-0.239	-0.240	-0.472
(38) Jan-June Total Rain	-0.262	-0.270	-0.255	-0.450	-0.451	-0.427	-0.428	-0.291	-0.289	-0.451
(39) (Jan-June Total Rain) ²	-0.239	-0.328	-0.311	-0.453	-0.452	-0.411	-0.414	-0.292	-0.292	-0.444
(40) June Avg Gain	0.063	-0.104	-0.102	-0.250	-0.244	-0.295	-0.294	-0.234	-0.234	-0.121

APPENDIX B-3

	11	12	13	14	15	16	17	18	19	20
(11) (May-June Avg Min Temp) ²	1.000									
(12) April-June Avg Min Temp	0.754	1.000								
(13) (April-June Avg Min Temp) ²	0.753	0.999	1.000							
(14) March-June Avg Min Temp	0.709	0.773	0.775	1.000						
(15) (March-June Avg Min Temp) ²	0.707	0.774	0.775	0.999	1.000					
(16) Feb-June Avg Min Temp	0.536	0.554	0.555	0.895	0.892	1.000				
(17) (Feb-June Avg Min Temp) ²	0.576	0.560	0.561	0.899	0.896	0.999	1.000			
(18) Jan-June Avg Min Temp	0.590	0.610	0.610	0.840	0.832	0.916	0.913	1.000		
(19) (Jan-June Avg Min Temp) ²	0.590	0.614	0.614	0.839	0.832	0.914	0.910	0.999	1.000	
(20) May-June Mean Temp	0.932	0.598	0.593	0.519	0.514	0.423	0.420	0.468	0.465	1.000
(21) (May-June Mean Temp) ²	0.932	0.593	0.588	0.516	0.511	0.422	0.419	0.466	0.463	0.999
(22) April-June Mean Temp	0.792	0.904	0.900	0.654	0.650	0.465	0.466	0.532	0.532	0.773
(23) (April-June Mean Temp) ²	0.794	0.907	0.902	0.656	0.652	0.466	0.468	0.533	0.533	0.772

APPENDIX B-4

	11	12	13	14	15	16	17	18	19	20
(24) March-June Mean Temp	0.766	0.749	0.747	0.914	0.911	0.828	0.827	0.785	0.782	0.684
(25) (March-June Mean Temp) ²	0.766	0.750	0.748	0.916	0.912	0.826	0.826	0.780	0.777	0.682
(26) Feb-June Mean Temp	0.606	0.543	0.541	0.806	0.800	0.925	0.922	0.865	0.860	0.546
(27) (Feb-June Mean Temp) ²	0.605	0.546	0.545	0.806	0.801	0.925	0.922	0.862	0.858	0.545
(28) Jan-June Mean Temp	0.554	0.510	0.509	0.677	0.668	0.806	0.799	0.903	0.902	0.527
(29) (Jan-June Mean Temp) ²	0.551	0.512	0.511	0.674	0.665	0.802	0.796	0.903	0.901	0.525
(30) May-June Total Rain	-0.360	-0.308	-0.300	-0.358	-0.356	-0.312	-0.314	-0.339	-0.339	-0.503
(31) (May-June Total Rain) ²	-0.366	-0.347	-0.339	-0.418	-0.413	-0.362	-0.363	-0.404	-0.402	-0.483
(32) April-June Total Rain	-0.439	-0.330	-0.322	-0.400	-0.398	-0.331	-0.333	-0.307	-0.304	-0.584
(33) (April-June Total Rain) ²	-0.435	-0.365	-0.357	-0.431	-0.426	-0.357	-0.358	-0.364	-0.361	-0.563
(34) March-June Total Rain	-0.415	-0.350	-0.342	-0.378	-0.375	-0.291	-0.292	-0.280	-0.277	-0.566
(35) (March-June Total Rain) ²	-0.427	-0.393	-0.384	-0.415	-0.411	-0.327	-0.328	-0.343	-0.341	-0.561
(36) Feb-June Total Rain	-0.469	-0.347	-0.340	-0.426	-0.424	-0.355	-0.357	-0.330	-0.327	-0.611

APPENDIX B-5

	11	12	13	14	15	16	17	18	19	20
(37) (Feb-June Total Rain) ²	-0.466	-0.388	-0.380	-0.455	-0.450	-0.380	-0.381	-0.386	-0.383	-0.595
(38) Jan-June Total Rain	-0.446	-0.291	-0.284	-0.421	-0.419	-0.397	-0.398	-0.360	-0.358	-0.586
(39) (Jan-June Total Rain) ²	-0.439	-0.328	-0.320	-0.450	-0.445	-0.419	-0.420	-0.410	-0.408	-0.568
(40) June Avg Gain	-0.121	-0.133	-0.133	-0.203	-0.199	-0.282	-0.280	-0.240	-0.238	-0.088

APPENDIX B-6

	21	22	23	24	25	26	27	28	29	30
(21) (May-June Mean Temp) ²	1.000									
(22) April-June Mean Temp	0.769	1.000								
(23) (April-June Mean Temp) ²	0.768	0.999	1.000							
(24) March-June Mean Temp	0.682	0.789	0.790	1.000						
(25) (March-June Mean Temp) ²	0.680	0.787	0.788	0.999	1.000					
(26) Feb-June Mean Temp	0.546	0.584	0.585	0.887	0.885	1.000				
(27) (Feb-June Mean Temp) ²	0.544	0.587	0.588	0.888	0.885	0.999	1.000			
(28) Jan-June Mean Temp	0.526	0.570	0.570	0.778	0.772	0.914	0.911	1.000		
(29) (Jan-June Mean Temp) ²	0.524	0.571	0.572	0.775	0.769	0.911	0.908	0.999	1.000	
(30) May-June Total Rain	-0.500	-0.512	-0.506	-0.514	-0.512	-0.444	-0.448	-0.424	-0.426	1.000
(31) (May-June Total Rain) ²	-0.479	-0.536	-0.528	-0.548	-0.544	-0.463	-0.466	-0.446	-0.447	0.970
(32) April-June Total Rain	-0.581	-0.570	-0.563	-0.578	-0.576	-0.481	-0.484	-0.407	-0.407	0.968
(33) (April-June Total Rain) ²	-0.559	-0.591	-0.583	-0.586	-0.582	-0.481	-0.484	-0.430	-0.430	0.949

APPENDIX B-7

	21	22	23	24	25	26	27	28	29	30
(34) March-June Total Rain	-0.562	-0.604	-0.597	-0.595	-0.594	-0.484	-0.489	-0.419	-0.420	0.936
(35) (March-June Total Rain) ²	-0.557	-0.630	-0.622	-0.603	-0.599	-0.488	-0.492	-0.443	-0.444	0.932
(36) Feb-June Total Rain	-0.608	-0.586	-0.579	-0.629	-0.628	-0.533	-0.537	-0.455	-0.455	0.945
(37) (Feb-June Total Rain) ²	-0.591	-0.613	-0.606	-0.631	-0.628	-0.528	-0.531	-0.473	-0.473	0.946
(38) Jan-June Total Rain	-0.584	-0.525	-0.519	-0.618	-0.618	-0.572	-0.576	-0.494	-0.494	0.940
(39) (Jan-June Total Rain) ²	-0.564	-0.551	-0.544	-0.623	-0.620	-0.566	-0.569	-0.506	-0.507	0.949
(40) June Avg Gain	-0.089	-0.124	-0.125	-0.225	-0.223	-0.292	-0.291	-0.248	-0.246	-0.012

APPENDIX B-8

	31	32	33	34	35	36	37	38	39	40
(31) (May-June Total Rain) ²	1.000									
(32) April-June Total Rain	0.951	1.000								
(33) (April-June Total Rain) ²	0.979	0.979	1.000							
(34) March-June Total Rain	0.930	0.978	0.962	1.000						
(35) (March-June Total Rain) ²	0.961	0.969	0.987	0.984	1.000					
(36) Feb-June Total Rain	0.929	0.983	0.957	0.989	0.968	1.000				
(37) (Feb-June Total Rain) ²	0.969	0.978	0.989	0.981	0.993	0.982	1.000			
(38) Jan-June Total Rain	0.917	0.970	0.938	0.972	0.945	0.992	0.967	1.000		
(39) (Jan-June Total Rain) ²	0.964	0.973	0.977	0.973	0.978	0.982	0.992	0.983	1.000	
(40) June Avg Gain	0.023	-0.000	0.021	0.016	0.026	0.036	0.041	0.052	0.055	1.000

APPENDIX C

CORRELATIONS BETWEEN FACTORS AFFECTING JULY STEER GAIN

	1	2	3	4	5	6	7	8	9	10
(1) July Avg Steer Wt	1.000									
(2) May Avg Max Temp	0.091	1.000								
(3) (May Avg Max Temp) ²	0.075	0.999	1.000							
(4) April-May Avg Max Temp	0.221	0.736	0.738	1.000						
(5) (April-May Avg Max Temp) ²	0.206	0.739	0.741	0.999	1.000					
(6) March-May Avg Max Temp	0.022	0.498	0.503	0.742	0.743	1.000				
(7) (March-May Avg Max Temp) ²	0.030	0.501	0.505	0.743	0.744	0.999	1.000			
(8) Feb-May Avg Max Temp	-0.261	0.148	0.158	0.435	0.435	0.833	0.828	1.000		
(9) (Feb-May Avg Max Temp) ²	-0.250	0.146	0.156	0.442	0.441	0.834	0.829	0.999	1.000	
(10) June-July Avg Min Temp	-0.042	-0.104	-0.101	0.289	0.285	0.496	0.492	0.670	0.675	1.000
(11) (June-July Avg Min Temp) ²	-0.038	-0.109	-0.107	0.284	0.280	0.494	0.490	0.672	0.676	0.999
(12) May-July Avg Min Temp	-0.044	0.494	0.497	0.638	0.639	0.784	0.781	0.698	0.698	0.741
(13) (May-July Avg Min Temp) ²	-0.039	0.496	0.498	0.638	0.638	0.784	0.781	0.697	0.697	0.738

APPENDIX C-1

	1	2	3	4	5	6	7	8	9	10
(14) April-July Avg Min Temp	0.100	0.324	0.324	0.694	0.693	0.718	0.716	0.609	0.614	0.736
(15) (April-July Avg Min Temp) ²	0.104	0.322	0.322	0.692	0.691	0.718	0.715	0.610	0.614	0.733
(16) March-July Avg Min Temp	-0.020	0.133	0.137	0.434	0.434	0.767	0.763	0.734	0.734	0.759
(17) (March-July Avg Min Temp) ²	-0.009	0.130	0.133	0.431	0.431	0.764	0.760	0.730	0.731	0.757
(18) Feb-July Avg Min Temp	-0.265	-0.032	-0.022	0.236	0.236	0.663	0.657	0.813	0.812	0.792
(19) (Feb-July Avg Min Temp) ²	-0.254	-0.036	-0.026	0.235	0.236	0.660	0.655	0.810	0.809	0.794
(20) June-July Mean Temp	-0.139	-0.170	-0.168	0.168	0.162	0.398	0.394	0.630	0.633	0.945
(21) (June-July Mean Temp) ²	-0.139	-0.176	-0.174	0.160	0.155	0.391	0.387	0.529	0.632	0.943
(22) May-July Mean Temp	-0.105	0.428	0.430	0.581	0.579	0.710	0.707	0.710	0.711	0.823
(23) (May-July Mean Temp) ²	-0.104	0.430	0.432	0.580	0.578	0.710	0.707	0.711	0.712	0.822
(24) April-July Mean Temp	0.046	0.353	0.354	0.753	0.750	0.764	0.762	0.705	0.710	0.833
(25) (April-July Mean Temp) ²	0.048	0.352	0.354	0.754	0.751	0.767	0.765	0.708	0.714	0.833
(26) March-July Mean Temp	-0.066	0.195	0.199	0.528	0.527	0.862	0.859	0.867	0.869	0.842

APPENDIX C-2

	1	2	3	4	5	6	7	8	9	10
(27) (March-July Mean Temp) ²	-0.057	0.194	0.198	0.529	0.527	0.864	0.861	0.868	0.870	0.842
(28) Feb-July Mean Temp	-0.277	-0.009	-0.001	0.303	0.302	0.717	0.711	0.924	0.924	0.862
(29) (Feb-July Mean Temp) ²	-0.269	-0.015	-0.006	0.304	0.302	0.715	0.709	0.924	0.924	0.866
(30) June-July Total Rain	0.128	0.070	0.064	-0.204	-0.200	-0.462	-0.459	-0.533	-0.532	-0.708
(31) (June-July Total Rain) ²	0.121	0.019	0.012	-0.292	-0.288	-0.516	-0.512	-0.553	-0.553	-0.688
(32) May-July Total Rain	-0.014	-0.021	-0.023	-0.338	-0.332	-0.487	-0.485	-0.526	-0.527	-0.794
(33) (May-July Total Rain) ²	0.003	-0.062	-0.066	-0.393	-0.388	-0.509	-0.505	-0.509	-0.511	-0.717
(34) April-July Total Rain	-0.016	-0.063	-0.066	-0.378	-0.373	-0.530	-0.527	-0.553	-0.555	-0.776
(35) (April-July Total Rain) ²	0.000	-0.092	-0.097	-0.419	-0.413	-0.529	-0.524	-0.520	-0.522	-0.706
(36) March-July Total Rain	-0.058	-0.093	-0.096	-0.434	-0.427	-0.583	-0.580	-0.594	-0.598	-0.765
(37) (March-July Total Rain) ²	-0.033	-0.113	-0.117	-0.452	-0.446	-0.559	-0.555	-0.549	-0.661	-0.697
(38) Feb-July Total Rain	-0.038	-0.102	-0.104	-0.401	-0.395	-0.586	-0.583	-0.608	-0.610	-0.765
(39) (Feb-July Total Rain) ²	-0.017	-0.116	-0.120	-0.429	-0.422	-0.564	-0.560	-0.564	-0.566	-0.700
(40) July Avg Gain	0.144	0.026	0.029	0.200	0.200	0.276	0.280	0.201	0.208	0.079

APPENDIX C-3

	11	12	13	14	15	16	17	18	19	20
(11) (June-July Avg Min Temp) ²	1.000									
(12) May-July Avg Min Temp	0.738	1.000								
(13) (May-July Avg Min Temp) ²	0.735	0.999	1.000							
(14) April-July Avg Min Temp	0.734	0.897	0.897	1.000						
(15) (April-July Avg Min Temp) ²	0.731	0.896	0.896	0.999	1.000					
(16) March-July Avg Min Temp	0.758	0.872	0.872	0.870	0.871	1.000				
(17) (March-July Avg Min Temp) ²	0.757	0.870	0.870	0.870	0.872	0.999	1.000			
(18) Feb-July Avg Min Temp	0.792	0.782	0.781	0.729	0.729	0.932	0.929	1.000		
(19) (Feb-July Avg Min Temp) ²	0.794	0.782	0.780	0.733	0.733	0.934	0.932	0.999	1.000	
(20) June-July Mean Temp	0.944	0.591	0.585	0.533	0.528	0.592	0.587	0.684	0.682	1.000
(21) (June-July Mean Temp) ²	0.942	0.584	0.578	0.525	0.520	0.584	0.580	0.679	0.677	0.999
(22) May-July Mean Temp	0.819	0.899	0.895	0.744	0.739	0.718	0.712	0.697	0.693	0.804
(23) (May-July Mean Temp) ²	0.818	0.898	0.895	0.742	0.737	0.715	0.710	0.695	0.691	0.803

APPENDIX C-4

	11	12	13	14	15	16	17	18	19	20
(24) April-July Mean Temp	0.829	0.872	0.869	0.903	0.899	0.775	0.771	0.685	0.685	0.743
(25) (April-July Mean Temp) ²	0.829	0.873	0.870	0.905	0.901	0.776	0.772	0.687	0.686	0.742
(26) March-July Mean Temp	0.840	0.872	0.870	0.813	0.810	0.917	0.913	0.887	0.885	0.770
(27) (March-July Mean Temp) ²	0.840	0.872	0.870	0.814	0.812	0.918	0.914	0.886	0.885	0.768
(28) Feb-July Mean Temp	0.863	0.756	0.753	0.669	0.667	0.829	0.825	0.927	0.924	0.836
(29) (Feb-July Mean Temp) ²	0.867	0.754	0.751	0.671	0.669	0.829	0.825	0.927	0.924	0.838
(30) June-July Total Rain	-0.705	-0.494	-0.489	-0.404	-0.398	-0.549	-0.545	-0.604	-0.602	-0.744
(31) (June-July Total Rain) ²	-0.683	-0.524	-0.520	-0.465	-0.459	-0.584	-0.578	-0.620	-0.618	-0.696
(32) May-July Total Rain	-0.791	-0.585	-0.581	-0.525	-0.520	-0.586	-0.583	-0.592	-0.592	-0.808
(33) (May-July Total Rain) ²	-0.712	-0.566	-0.561	-0.527	-0.522	-0.586	-0.580	-0.576	-0.574	-0.719
(34) April-July Total Rain	-0.773	-0.595	-0.590	-0.517	-0.512	-0.591	-0.587	-0.589	-0.588	-0.790
(35) (April-July Total Rain) ²	-0.700	-0.567	-0.563	-0.514	-0.509	-0.578	-0.572	-0.564	-0.562	-0.714
(36) March-July Total Rain	-0.762	-0.592	-0.587	-0.528	-0.523	-0.584	-0.580	-0.569	-0.569	-0.782

APPENDIX C-5

	11	12	13	14	15	16	17	18	19	20
(37) (March-July Total Rain) ²	-0.693	-0.761	-0.557	-0.516	-0.510	-0.566	-0.560	-0.545	-0.543	-0.708
(38) Feb-July Total Rain	-0.763	-0.609	-0.605	-0.519	-0.514	-0.599	-0.596	-0.593	-0.592	-0.784
(39) (Feb-July Total Rain) ²	-0.695	-0.573	-0.569	-0.509	-0.504	-0.578	-0.573	-0.565	-0.563	-0.713
(40) July Avg Gain	0.079	0.056	0.055	0.129	0.127	0.119	0.118	0.081	0.082	0.062

APPENDIX C-6

	21	22	23	24	25	26	27	28	29	30
(21) (June-July Mean Temp) ²	1.000									
(22) May-July Mean Temp	0.799	1.000								
(23) (May-July Mean Temp) ²	0.799	0.999	1.000							
(24) April-July Mean Temp	0.737	0.903	0.902	1.000						
(25) (April-July Mean Temp) ²	0.736	0.902	0.900	0.999	1.000					
(26) March-July Mean Temp	0.764	0.874	0.872	0.886	0.886	1.000				
(27) (March-July Mean Temp) ²	0.762	0.871	0.870	0.885	0.886	0.999	1.000			
(28) Feb-July Mean Temp	0.834	0.808	0.807	0.769	0.771	0.933	0.932	1.000		
(29) (Feb-July Mean Temp) ²	0.836	0.806	0.806	0.771	0.773	0.933	0.932	0.999	1.000	
(30) June-July Total Rain	-0.741	-0.640	-0.639	-0.588	-0.584	-0.690	-0.686	-0.687	-0.685	1.000
(31) (June-July Total Rain) ²	-0.690	-0.632	-0.630	-0.623	-0.618	-0.705	-0.700	-0.682	-0.681	0.967
(32) May-July Total Rain	-0.803	-0.739	-0.737	-0.716	-0.712	-0.732	-0.729	-0.692	-0.692	0.945
(33) (May-July Total Rain) ²	-0.713	-0.689	-0.686	-0.699	-0.694	-0.709	-0.704	-0.651	-0.650	0.898

APPENDIX C-7

	21	22	23	24	25	26	27	28	29	30
(34) April-July Total Rain	-0.786	-0.748	-0.746	-0.722	-0.718	-0.747	-0.744	-0.697	-0.697	0.939
(35) (April-July Total Rain) ²	-0.708	-0.699	-0.696	-0.703	-0.698	-0.713	-0.708	-0.650	-0.649	0.895
(36) March-July Total Rain	-0.778	-0.752	-0.751	-0.746	-0.742	-0.763	-0.761	-0.704	-0.705	0.917
(37) (March-July Total Rain) ²	-0.703	-0.701	-0.698	-0.715	-0.710	-0.719	-0.715	-0.653	-0.652	0.881
(38) Feb-July Total Rain	-0.781	-0.765	-0.764	-0.731	-0.727	-0.772	-0.770	-0.721	-0.721	0.918
(39) (Feb-July Total Rain) ²	-0.708	-0.710	-0.708	-0.705	-0.701	-0.729	-0.725	-0.670	-0.669	0.886
(40) July Avg Gain	0.060	0.062	0.062	0.160	0.161	0.184	0.186	0.129	0.133	-0.077

APPENDIX C-8

	31	32	33	34	35	36	37	38	39	40
(31) (June-July Total Rain) ²	1.000									
(32) May-July Total Rain	0.946	1.000								
(33) (May-July Total Rain) ²	0.957	0.967	1.000							
(34) April-July Total Rain	0.941	0.990	0.965	1.000						
(35) (April-July Total Rain) ²	0.948	0.962	0.995	0.973	1.000					
(36) March-July Total Rain	0.929	0.977	0.960	0.991	0.970	1.000				
(37) (March-July Total Rain) ²	0.936	0.955	0.989	0.969	0.995	0.978	1.000			
(38) Feb-July Total Rain	0.926	0.978	0.955	0.991	0.965	0.996	0.971	1.000		
(39) (Feb-July Total Rain) ²	0.938	0.959	0.988	0.971	0.994	0.978	0.998	0.977	1.000	
(40) July Avg Gain	-0.122	-0.058	-0.088	-0.068	-0.085	-0.126	-0.115	-0.099	-0.100	1.000

APPENDIX D

CORRELATIONS BETWEEN FACTORS AFFECTING AUGUST STEER GAIN

	1	2	3	4	5	6	7	8	9	10
(1) Aug Avg Steer Wt	1.000									
(2) June Avg Max Temp	-0.131	1.000								
(3) (June Avg Max Temp) ²	-0.133	0.999	1.000							
(4) May-June Avg Max Temp	-0.035	0.701	0.699	1.000						
(5) (May-June Avg Max Temp) ²	-0.041	0.704	0.702	0.999	1.000					
(6) April-June Avg Max Temp	0.134	0.494	0.486	0.802	0.797	1.000				
(7) (April-June Avg Max Temp) ²	0.131	0.492	0.484	0.803	0.798	0.999	1.000			
(8) March-June Avg Max Temp	0.005	0.518	0.508	0.677	0.675	0.819	0.821	1.000		
(9) (March-June Avg Max Temp) ²	0.012	0.514	0.506	0.675	0.673	0.817	0.818	0.999	1.000	
(10) July-Aug Avg Min Temp	0.076	-0.080	-0.086	-0.149	-0.151	0.244	0.247	0.424	0.428	1.000
(11) (July-Aug Avg Min Temp) ²	0.081	-0.078	-0.085	-0.152	-0.154	0.244	0.247	0.427	0.431	0.999
(12) June-Aug Avg Min Temp	-0.002	0.443	0.437	0.239	0.237	0.518	0.519	0.658	0.659	0.836
(13) (June-Aug Avg Min Temp) ²	0.001	0.445	0.438	0.235	0.233	0.516	0.517	0.659	0.660	0.835

APPENDIX D-1

	1	2	3	4	5	6	7	8	9	10
(14) May-Aug Avg Min Temp	-0.012	0.218	0.210	0.435	0.431	0.662	0.664	0.789	0.790	0.747
(15) (May-Aug Avg Min Temp) ²	-0.008	0.218	0.209	0.435	0.431	0.661	0.664	0.791	0.792	0.744
(16) April-Aug Avg Min Temp	0.116	0.036	0.027	0.203	0.196	0.593	0.594	0.640	0.640	0.835
(17) (April-Aug Avg Min Temp) ²	0.119	0.034	0.025	0.199	0.192	0.591	0.592	0.641	0.640	0.833
(18) March-Aug Avg Min Temp	0.119	0.152	0.141	0.178	0.173	0.460	0.460	0.723	0.723	0.806
(19) (March-Aug Avg Min Temp) ²	0.120	0.152	0.140	0.175	0.169	0.456	0.457	0.721	0.721	0.804
(20) July-Aug Mean Temp	-0.035	0.208	0.206	0.064	0.064	0.384	0.387	0.532	0.534	0.920
(21) (July-Aug Mean Temp) ²	-0.031	0.209	0.206	0.059	0.059	0.384	0.386	0.536	0.538	0.920
(22) June-Aug Mean Temp	-0.097	0.640	0.637	0.388	0.389	0.554	0.555	0.670	0.670	0.684
(23) (June-Aug Mean Temp) ²	-0.097	0.645	0.643	0.387	0.389	0.553	0.554	0.670	0.670	0.679
(24) May-Aug Mean Temp	-0.074	0.522	0.518	0.638	0.638	0.779	0.782	0.841	0.841	0.638
(25) (May-Aug Mean Temp) ²	-0.073	0.526	0.522	0.642	0.641	0.781	0.784	0.845	0.846	0.636
(26) April-Aug Mean Temp	0.060	0.339	0.332	0.466	0.462	0.804	0.805	0.796	0.796	0.751

APPENDIX D-2

	1	2	3	4	5	6	7	8	9	10
(27) (April-Aug Mean Temp) ²	0.062	0.337	0.330	0.463	0.459	0.804	0.805	0.799	0.798	0.752
(28) March-Aug Mean Temp	-0.028	0.392	0.383	0.416	0.414	0.669	0.670	0.890	0.890	0.756
(29) (March-Aug Mean Temp) ²	-0.020	0.390	0.381	0.414	0.411	0.667	0.669	0.891	0.891	0.758
(30) July-Aug Total Rain	0.196	-0.401	-0.397	-0.265	-0.265	-0.469	-0.469	-0.628	-0.623	-0.529
(31) (July-Aug Total Rain) ²	0.211	-0.398	-0.393	-0.307	-0.307	-0.519	-0.519	-0.633	-0.627	-0.526
(32) June-Aug Total Rain	0.102	-0.565	-0.562	-0.375	-0.375	-0.484	-0.482	-0.667	-0.662	-0.353
(33) (June-Aug Total Rain) ²	0.109	-0.520	-0.513	-0.378	-0.378	-0.527	-0.524	-0.674	-0.668	-0.362
(34) May-Aug Total Rain	-0.019	-0.611	-0.606	-0.471	-0.470	-0.620	-0.617	-0.706	-0.702	-0.379
(35) (May-Aug Total Rain) ²	0.001	-0.556	-0.546	-0.457	-0.455	-0.631	-0.627	-0.684	-0.678	-0.338
(36) April-Aug Total Rain	-0.023	-0.634	-0.627	-0.516	-0.515	-0.666	-0.663	-0.751	-0.746	-0.362
(37) (April-Aug Total Rain) ²	-0.001	-0.579	-0.568	-0.496	-0.494	-0.667	-0.663	-0.714	-0.708	-0.319
(38) March-Aug Total Rain	-0.070	-0.630	-0.622	-0.534	-0.532	-0.711	-0.708	-0.793	-0.789	-0.372
(39) (March-Aug Total Rain) ²	-0.035	-0.586	-0.575	-0.514	-0.512	-0.699	-0.695	-0.743	-0.737	-0.315
(40) August Avg Gain	-0.208	-0.176	-0.176	-0.260	-0.259	-0.382	-0.382	-0.267	-0.268	-0.134

APPENDIX D-3

	11	12	13	14	15	16	17	18	19	20
(11) (July-Aug Avg Min Temp) ²	1.000									
(12) June-Aug Avg Min Temp	0.836	1.000								
(13) (June-Aug Avg Min Temp) ²	0.836	0.999	1.000							
(14) May-Aug Avg Min Temp	0.744	0.816	0.813	1.000						
(15) (May-Aug Avg Min Temp) ²	0.742	0.814	0.811	0.999	1.000					
(16) April-Aug Avg Min Temp	0.834	0.813	0.812	0.930	0.930	1.000				
(17) (April-Aug Avg Min Temp) ²	0.833	0.812	0.810	0.929	0.929	0.999	1.000			
(18) March-Aug Avg Min Temp	0.808	0.829	0.829	0.916	0.918	0.900	0.902	1.000		
(19) (March-Aug Avg Min Temp) ²	0.806	0.827	0.828	0.913	0.915	0.899	0.901	0.999	1.000	
(20) July-Aug Mean Temp	0.918	0.903	0.900	0.724	0.719	0.749	0.744	0.742	0.736	1.000
(21) (July-Aug Mean Temp) ²	0.919	0.902	0.899	0.719	0.714	0.747	0.742	0.741	0.736	0.999
(22) June-Aug Mean Temp	0.683	0.933	0.931	0.688	0.684	0.626	0.621	0.667	0.662	0.882
(23) (June-Aug Mean Temp) ²	0.679	0.932	0.930	0.682	0.678	0.620	0.616	0.662	0.657	0.879

APPENDIX D-4

	11	12	13	14	15	16	17	18	19	20
(24) May-Aug Mean Temp	0.635	0.843	0.838	0.887	0.883	0.765	0.760	0.750	0.744	0.793
(25) (May-Aug Mean Temp) ²	0.632	0.842	0.837	0.886	0.883	0.762	0.757	0.749	0.743	0.791
(26) April-Aug Mean Temp	0.750	0.872	0.869	0.898	0.896	0.896	0.893	0.802	0.797	0.832
(27) (April-Aug Mean Temp) ²	0.751	0.873	0.870	0.898	0.895	0.897	0.894	0.803	0.798	0.832
(28) March-Aug Mean Temp	0.758	0.886	0.885	0.911	0.910	0.836	0.835	0.914	0.910	0.829
(29) (March-Aug Mean Temp) ²	0.759	0.886	0.886	0.910	0.910	0.837	0.836	0.915	0.912	0.828
(30) July-Aug Total Rain	-0.526	-0.731	-0.726	-0.662	-0.659	-0.612	-0.609	-0.709	-0.703	-0.682
(31) (July-Aug Total Rain) ²	-0.522	-0.732	-0.726	-0.682	-0.679	-0.630	-0.627	-0.696	-0.688	-0.673
(32) June-Aug Total Rain	-0.354	-0.656	-0.653	-0.528	-0.527	-0.435	-0.433	-0.590	-0.587	-0.555
(33) (June-Aug Total Rain) ²	-0.363	-0.648	-0.644	-0.550	-0.549	-0.474	-0.472	-0.602	-0.598	-0.538
(34) May-Aug Total Rain	-0.380	-0.699	-0.696	-0.581	-0.581	-0.518	-0.517	-0.606	-0.604	-0.570
(35) (May-Aug Total Rain) ²	-0.340	-0.637	-0.634	-0.553	-0.552	-0.505	-0.504	-0.584	-0.579	-0.508
(36) April-Aug Total Rain	-0.364	-0.697	-0.695	-0.599	-0.599	-0.519	-0.518	-0.617	-0.615	-0.555

APPENDIX D-5

	11	12	13	14	15	16	17	18	19	20
(37) (April-Aug Total Rain) ²	-0.321	-0.632	-0.629	-0.560	-0.559	-0.499	-0.498	-0.583	-0.579	-0.496
(38) March-Aug Total Rain	-0.375	-0.701	-0.700	-0.606	-0.606	-0.535	-0.535	-0.617	-0.615	-0.559
(39)(March-Aug Total Rain) ²	-0.318	-0.631	-0.629	-0.558	-0.558	-0.504	-0.502	-0.576	-0.572	-0.488
(40) August Avg Gain	-0.133	-0.270	-0.270	-0.262	-0.263	-0.264	-0.264	-0.164	-0.166	-0.172

APPENDIX D-6

	21	22	23	24	25	26	27	28	29	30
(21) (July-Aug Mean Temp) ²	1.000									
(22) June-Aug Mean Temp	0.881	1.000								
(23) (June-Aug Mean Temp) ²	0.878	0.999	1.000							
(24) May-Aug Mean Temp	0.788	0.877	0.873	1.000						
(25) (May-Aug Mean Temp) ²	0.786	0.877	0.873	0.999	1.000					
(26) April-Aug Mean Temp	0.831	0.829	0.826	0.937	0.936	1.000				
(27) (April-Aug Mean Temp) ²	0.831	0.828	0.825	0.935	0.934	0.999	1.000			
(28) March-Aug Mean Temp	0.830	0.844	0.841	0.918	0.919	0.917	0.919	1.000		
(29) (March-Aug Mean Temp) ²	0.829	0.842	0.839	0.915	0.916	0.916	0.917	0.999	1.000	
(30) July-Aug Total Rain	-0.678	-0.748	-0.743	-0.720	-0.718	-0.713	-0.711	-0.780	-0.776	1.000
(31) (July-Aug Total Rain) ²	-0.667	-0.743	-0.737	-0.739	-0.737	-0.737	-0.734	-0.774	-0.768	0.984
(32) June-Aug Total Rain	-0.554	-0.723	-0.722	-0.660	-0.660	-0.608	-0.607	-0.720	-0.717	0.919
(33) (June-Aug Total Rain) ²	-0.537	-0.692	-0.690	-0.656	-0.656	-0.630	-0.628	-0.718	-0.715	0.917

APPENDIX D-7

	21	22	23	24	25	26	27	28	29	30
(34) May-Aug Total Rain	-0.570	-0.755	-0.753	-0.720	-0.720	-0.697	-0.696	-0.744	-0.742	0.894
(35) (May-Aug Total Rain) ²	-0.509	-0.683	-0.680	-0.671	-0.671	-0.672	-0.670	-0.705	-0.701	0.868
(36) April-Aug Total Rain	-0.555	-0.755	-0.753	-0.737	-0.738	-0.711	-0.710	-0.763	-0.761	0.887
(37) (April-Aug Total Rain) ²	-0.497	-0.684	-0.682	-0.684	-0.685	-0.680	-0.678	-0.715	-0.711	0.861
(38) March-Aug Total Rain	-0.561	-0.755	-0.754	-0.747	-0.749	-0.735	-0.735	-0.781	-0.780	0.854
(39) (March-Aug Total Rain) ²	-0.491	-0.681	-0.680	-0.686	-0.687	-0.691	-0.690	-0.721	-0.718	0.831
(40) August Avg Gain	-0.171	-0.238	-0.238	-0.289	-0.290	-0.327	-0.327	-0.234	-0.236	0.200

APPENDIX D-8

	31	32	33	34	35	36	37	38	39	40
(31) (July-Aug Total Rain) ²	1.000									
(32) June-Aug Total Rain	0.895	1.000								
(33) (June-Aug Total Rain) ²	0.927	0.973	1.000							
(34) May-Aug Total Rain	0.889	0.954	0.958	1.000						
(35) (May-Aug Total Rain) ²	0.894	0.910	0.965	0.972	1.000					
(36) April-Aug Total Rain	0.884	0.948	0.955	0.992	0.970	1.000				
(37) (April-Aug Total Rain) ²	0.887	0.907	0.958	0.966	0.996	0.976	1.000			
(38) March-Aug Total Rain	0.857	0.929	0.943	0.980	0.966	0.992	0.973	1.000		
(39) (March-Aug Total Rain) ²	0.860	0.892	0.947	0.958	0.990	0.970	0.996	0.979	1.000	
(40) August Avg Gain	0.214	0.241	0.239	0.296	0.262	0.302	0.267	0.316	0.280	1.000

APPENDIX E

CORRELATIONS BETWEEN FACTORS AFFECTING SEPTEMBER STEER GAIN

	1	2	3	4	5	6	7	8	9	10
(1) Sept Avg Steer Wt	1.000									
(2) July Avg Max Temp	-0.160	1.000								
(3) (July Avg Max Temp) ²	-0.155	0.999	1.000							
(4) June-July Avg Max Temp	-0.194	0.843	0.843	1.000						
(5) (June-July Avg Max Temp) ²	-0.196	0.838	0.838	0.999	1.000					
(6) May-July Avg Max Temp	-0.154	0.698	0.693	0.863	0.860	1.000				
(7) (May-July Avg Max Temp) ²	-0.156	0.696	0.691	0.864	0.861	0.999	1.000			
(8) April-July Avg Max Temp	-0.018	0.742	0.740	0.774	0.769	0.916	0.912	1.000		
(9) (April-July Avg Max Temp) ²	-0.019	0.744	0.743	0.775	0.770	0.916	0.912	0.999	1.000	
(10) Aug-Sept Avg Min Temp	0.266	0.437	0.440	0.250	0.242	0.262	0.254	0.523	0.523	1.000
(11) (Aug-Sept Avg Min Temp) ²	0.262	0.441	0.444	0.257	0.249	0.261	0.254	0.523	0.523	0.999
(12) July-Sept Avg Min Temp	0.212	0.665	0.665	0.373	0.364	0.359	0.351	0.604	0.605	0.922
(13) (July-Sept Avg Min Temp) ²	0.213	0.666	0.667	0.377	0.367	0.358	0.350	0.605	0.606	0.922

APPENDIX E-1

	1	2	3	4	5	6	7	8	9	10
(14) June-Sept Avg Min Temp	0.125	0.760	0.760	0.645	0.637	0.606	0.599	0.780	0.780	0.863
(15) (June-Sept Avg Min Temp) ²	0.127	0.756	0.757	0.642	0.634	0.598	0.592	0.774	0.774	0.864
(16) May-Sept Avg Min Temp	0.102	0.586	0.580	0.449	0.438	0.606	0.598	0.773	0.772	0.811
(17) (May-Sept Avg Min Temp) ²	0.104	0.583	0.578	0.447	0.436	0.603	0.595	0.770	0.769	0.812
(18) April-Sept Avg Min Temp	0.167	0.588	0.585	0.378	0.367	0.486	0.477	0.717	0.715	0.846
(19) (April-Sept Avg Min Temp) ²	0.169	0.587	0.584	0.377	0.366	0.482	0.473	0.714	0.713	0.845
(20) Aug-Sept Mean Temp	0.176	0.669	0.672	0.663	0.659	0.629	0.626	0.752	0.754	0.800
(21) (Aug-Sept Mean Temp) ²	0.174	0.669	0.672	0.661	0.657	0.623	0.620	0.749	0.750	0.801
(22) July-Sept Mean Temp	0.083	0.876	0.877	0.760	0.754	0.687	0.684	0.807	0.809	0.748
(23) (July-Sept Mean Temp) ²	0.085	0.874	0.876	0.758	0.752	0.682	0.678	0.805	0.807	0.750
(24) June-Sept Mean Temp	0.004	0.852	0.852	0.904	0.901	0.819	0.817	0.857	0.858	0.609
(25) (June-Sept Mean Temp) ²	0.003	0.851	0.852	0.904	0.901	0.816	0.814	0.854	0.856	0.610
(26) May-Sept Mean Temp	0.012	0.763	0.760	0.806	0.801	0.903	0.900	0.945	0.945	0.629

APPENDIX E-2

	1	2	3	4	5	6	7	8	9	10
(27) (May-Sept Mean Temp) ²	0.013	0.763	0.760	0.807	0.802	0.902	0.899	0.944	0.945	0.629
(28) April-Sept Mean Temp	0.088	0.767	0.765	0.719	0.712	0.808	0.803	0.947	0.946	0.738
(29) (April-Sept Mean Temp) ²	0.090	0.768	0.767	0.719	0.712	0.805	0.800	0.946	0.946	0.741
(30) Aug-Sept Total Rain	-0.136	-0.430	-0.442	-0.580	-0.581	-0.541	-0.544	-0.502	-0.505	-0.171
(31) (Aug-Sept Total Rain) ²	-0.081	-0.441	-0.453	-0.593	-0.594	-0.531	-0.533	-0.480	-0.483	-0.181
(32) July-Sept Total Rain	0.130	-0.724	-0.723	-0.793	-0.787	-0.743	-0.741	-0.753	-0.752	-0.309
(33) (July-Sept Total Rain) ²	0.173	-0.656	-0.655	-0.716	-0.709	-0.684	-0.681	-0.710	-0.708	-0.276
(34) June-Sept Total Rain	0.074	-0.600	-0.601	-0.750	-0.747	-0.691	-0.691	-0.664	-0.662	-0.234
(35) (June-Sept Total Rain) ²	0.092	-0.556	-0.558	-0.681	-0.676	-0.634	-0.632	-0.634	-0.631	-0.239
(36) May-Sept Total Rain	-0.018	-0.626	-0.627	-0.784	-0.780	-0.759	-0.758	-0.752	-0.750	-0.270
(37) (May-Sept Total Rain) ²	0.004	-0.566	-0.568	-0.710	-0.704	-0.700	-0.697	-0.722	-0.718	-0.272
(38) April-Sept Total Rain	-0.021	-0.597	-0.598	-0.778	-0.773	-0.770	-0.769	-0.769	-0.767	-0.296
(39) (April-Sept Total Rain) ²	0.002	-0.547	-0.548	-0.711	-0.705	-0.716	-0.713	-0.741	-0.737	-0.286
(40) September Avg Gain	-0.167	0.024	0.024	0.092	0.094	0.067	0.069	-0.029	-0.030	-0.072

APPENDIX E-3

	11	12	13	14	15	16	17	18	19	20
(11) (Aug-Sept Avg Min Temp) ²	1.000									
(12) July-Sept Avg Min Temp	0.921	1.000								
(13) (July-Sept Avg Min Temp) ²	0.922	0.999	1.000							
(14) June-Sept Avg Min Temp	0.865	0.923	0.925	1.000						
(15) (June-Sept Avg Min Temp) ²	0.866	0.923	0.925	0.999	1.000					
(16) May-Sept Avg Min Temp	0.808	0.874	0.872	0.905	0.901	1.000				
(17) (May-Sept Avg Min Temp) ²	0.808	0.874	0.872	0.905	0.902	0.999	1.000			
(18) April-Sept Avg Min Temp	0.842	0.923	0.922	0.910	0.908	0.968	0.968	1.000		
(19) (April-Sept Avg Min Temp) ²	0.842	0.924	0.923	0.911	0.909	0.968	0.968	0.999	1.000	
(20) Aug-Sept Mean Temp	0.802	0.757	0.758	0.848	0.846	0.692	0.689	0.668	0.665	1.000
(21) (Aug-Sept Mean Temp) ²	0.803	0.758	0.759	0.846	0.844	0.688	0.685	0.665	0.662	0.999
(22) July-Sept Mean Temp	0.750	0.839	0.840	0.911	0.908	0.753	0.750	0.748	0.746	0.935
(23) (July-Sept Mean Temp) ²	0.752	0.840	0.841	0.910	0.907	0.749	0.746	0.745	0.743	0.936

APPENDIX E-4

	11	12	13	14	15	16	17	18	19	20
(24) June-Sept Mean Temp	0.613	0.672	0.674	0.861	0.858	0.682	0.679	0.638	0.635	0.911
(25) (June-Sept Mean Temp) ²	0.614	0.671	0.674	0.860	0.858	0.678	0.675	0.634	0.632	0.912
(26) May-Sept Mean Temp	0.628	0.687	0.686	0.853	0.847	0.821	0.818	0.743	0.739	0.873
(27) (May-Sept Mean Temp) ²	0.628	0.687	0.685	0.853	0.847	0.819	0.816	0.740	0.736	0.874
(28) April-Sept Mean Temp	0.737	0.801	0.801	0.916	0.912	0.882	0.879	0.856	0.853	0.880
(29) (April-Sept Mean Temp) ²	0.741	0.804	0.805	0.918	0.914	0.881	0.879	0.856	0.854	0.882
(30) Aug-Sept Total Rain	-0.179	-0.220	-0.231	-0.387	-0.391	-0.294	-0.299	-0.242	-0.248	-0.475
(31) (Aug-Sept Total Rain) ²	-0.189	-0.224	-0.234	-0.402	-0.406	-0.297	-0.302	-0.244	-0.248	-0.475
(32) July-Sept Total Rain	-0.314	-0.428	-0.432	-0.649	-0.645	-0.565	-0.565	-0.514	-0.515	-0.602
(33) (July-Sept Total Rain) ²	-0.281	-0.387	-0.390	-0.596	-0.592	-0.537	-0.536	-0.492	-0.492	-0.532
(34) June-Sept Total Rain	-0.240	-0.292	-0.297	-0.539	-0.537	-0.435	-0.436	-0.364	-0.365	-0.561
(35) (June-Sept Total Rain) ²	-0.245	-0.294	-0.299	-0.520	-0.518	-0.435	-0.436	-0.373	-0.374	-0.516
(36) May-Sept Total Rain	-0.275	-0.346	-0.352	-0.597	-0.594	-0.499	-0.500	-0.441	-0.442	-0.593

APPENDIX E-5

	11	12	13	14	15	16	17	18	19	20
(37) (May-Sept Total Rain) ²	-0.276	-0.333	-0.338	-0.566	-0.563	-0.489	-0.490	-0.441	-0.441	-0.547
(38) April-Sept Total Rain	-0.301	-0.349	-0.355	-0.608	-0.606	-0.521	-0.522	-0.450	-0.451	-0.618
(39) (April-Sept Total Rain) ²	-0.290	-0.330	-0.335	-0.572	-0.568	-0.503	-0.503	-0.445	-0.445	-0.566
(40) September Avg Gain	-0.072	-0.106	-0.108	-0.072	-0.074	-0.123	-0.126	-0.149	-0.152	-0.018

APPENDIX E-6

	21	22	23	24	25	26	27	28	29	30
(21) (Aug-Sept Mean Temp) ²	1.000									
(22) July-Sept Mean Temp	0.935	1.000								
(23) (July-Sept Mean Temp) ²	0.936	0.999	1.000							
(24) June-Sept Mean Temp	0.909	0.948	0.946	1.000						
(25) (June-Sept Mean Temp) ²	0.910	0.947	0.946	0.999	1.000					
(26) May-Sept Mean Temp	0.868	0.898	0.894	0.936	0.933	1.000				
(27) (May-Sept Mean Temp) ²	0.870	0.899	0.895	0.937	0.934	0.999	1.000			
(28) April-Sept Mean Temp	0.877	0.919	0.917	0.906	0.903	0.968	0.967	1.000		
(29) (April-Sept Mean Temp) ²	0.879	0.921	0.919	0.907	0.904	0.967	0.966	0.999	1.000	
(30) Aug-Sept Total Rain	-0.479	-0.478	-0.486	-0.570	-0.574	-0.536	-0.542	-0.481	-0.486	1.000
(31) (Aug-Sept Total Rain) ²	-0.478	-0.479	-0.486	-0.577	-0.581	-0.531	-0.536	-0.471	-0.475	0.989
(32) July-Sept Total Rain	-0.600	-0.693	-0.690	-0.782	-0.779	-0.762	-0.762	-0.732	-0.732	0.744
(33) (July-Sept Total Rain) ²	-0.531	-0.620	-0.617	-0.706	-0.702	-0.700	-0.699	-0.682	-0.681	0.686

APPENDIX E-7

	21	22	23	24	25	26	27	28	29	30
(34) June-Sept Total Rain	-0.559	-0.596	-0.594	-0.721	-0.718	-0.684	-0.685	-0.626	-0.626	0.804
(35) (June-Sept Total Rain) ²	-0.514	-0.552	-0.552	-0.663	-0.661	-0.637	-0.638	-0.598	-0.597	0.768
(36) May-Sept Total Rain	-0.590	-0.636	-0.634	-0.762	-0.760	-0.743	-0.744	-0.702	-0.701	0.812
(37) (May-Sept Total Rain) ²	-0.545	-0.582	-0.581	-0.700	-0.696	-0.693	-0.693	-0.670	-0.668	0.748
(38) April-Sept Total Rain	-0.616	-0.638	-0.637	-0.771	-0.769	-0.764	-0.765	-0.718	-0.718	0.798
(39) (April-Sept Total Rain) ²	-0.564	-0.584	-0.583	-0.709	-0.706	-0.712	-0.711	-0.685	-0.683	0.737
(40) September Avg Gain	-0.018	-0.028	-0.031	0.017	0.017	-0.016	-0.017	-0.069	-0.072	0.147

APPENDIX E-8

	31	32	33	34	35	36	37	38	39	40
(31) (Aug-Sept Total Rain) ²	1.000									
(32) July-Sept Total Rain	0.775	1.000								
(33) (July-Sept Total Rain) ²	0.731	0.980	1.000							
(34) June-Sept Total Rain	0.838	0.964	0.934	1.000						
(35) (June-Sept Total Rain) ²	0.816	0.951	0.962	0.977	1.000					
(36) May-Sept Total Rain	0.831	0.954	0.927	0.968	0.954	1.000				
(37) (May-Sept Total Rain) ²	0.780	0.928	0.942	0.936	0.967	0.974	1.000			
(38) April-Sept Total Rain	0.814	0.947	0.922	0.964	0.951	0.994	0.972	1.000		
(39) (April-Sept Total Rain) ²	0.765	0.921	0.933	0.932	0.960	0.970	0.997	0.977	1.000	
(40) September Avg Gain	0.120	0.130	0.115	0.122	0.106	0.092	0.076	0.104	0.083	1.000

APPENDIX F

MONTHLY MEAN TEMPERATURES (°F)

	December	January	February	March	April	May	June	July	August	September
1950	30.2	28.8	35.9	40.0	50.9	65.0	74.0	70.9	71.9	66.4
1951	29.6	28.7	34.0	37.6	50.0	64.8	69.2	76.0	77.3	64.0
1952	27.9	31.6	38.4	37.9	51.8	63.5	81.7	79.9	78.2	69.9
1953	34.4	30.5	37.6	45.0	51.1	63.9	81.6	79.2	77.4	70.9
1954	35.8	27.8	43.9	40.6	60.7	59.9	76.7	84.7	81.2	76.2
1955	29.7	30.7	28.0	42.1	61.7	66.7	70.9	84.4	80.6	73.3
1956	35.8	25.5	33.2	44.1	53.0	60.6	77.0	80.3	80.9	73.9
1957	38.7	25.1	36.8	43.5	52.7	63.4	72.8	82.2	80.0	65.2
1958	31.1	31.3	27.7	36.1	53.3	66.5	73.4	75.9	76.9	69.7
1959	38.2	24.1	31.9	45.9	54.3	67.2	75.4	75.5	82.3	69.0
1960	32.2	28.0	25.7	29.7	51.6	63.8	73.0	76.1	78.4	71.1
1961	25.0	29.9	36.6	44.9	51.4	61.4	72.6	78.5	75.8	64.5
1962	33.9	24.1	24.1	40.0	54.0	73.7	73.2	77.2	77.8	66.5
1963	25.4	19.3	34.2	47.7	58.9	65.9	77.1	82.1	80.2	72.5
1964	30.5	35.3	34.7	31.6	57.5	69.4	73.7	82.7	75.5	69.7
1965	40.3	31.7	31.0	34.1	58.5	69.7	73.6	78.6	77.1	67.2

APPENDIX G

MONTHLY MEAN TEMPERATURES (°C)

	December	January	February	March	April	May	June	July	August	September
1950	-1.9	-1.8	2.2	4.4	10.5	18.3	23.3	21.6	22.2	19.1
1951	-1.0	-1.8	1.1	3.1	10.0	18.2	20.7	24.4	25.2	17.8
1952	-1.3	-0.2	3.6	3.0	11.0	17.5	27.6	26.6	25.7	21.1
1953	-2.3	-0.8	3.1	7.2	10.6	17.7	27.6	26.2	25.2	21.6
1954	-3	-2.3	6.6	4.8	15.9	15.5	24.8	29.3	27.3	24.6
1955	2.1	-0.7	-2.2	5.6	16.5	19.3	21.6	29.0	27.0	22.9
1956	-1.3	-3.6	0.7	6.7	11.7	20.9	25.0	26.8	27.2	23.3
1957	2.1	-3.8	2.7	6.4	11.5	17.4	22.7	27.9	26.7	18.4
1958	3.7	-0.4	-2.4	2.3	11.8	19.2	23.0	24.4	24.9	20.9
1959	-0.5	-4.4	-0.1	7.7	12.4	19.6	24.1	24.1	27.9	20.6
1960	3.4	-2.2	-3.5	-1.3	10.9	17.7	22.8	24.5	25.8	21.7
1961	0.1	-1.2	2.6	7.2	10.8	16.3	22.6	25.8	24.3	18.1
1962	-3.9	-4.4	1.2	4.4	12.2	23.2	22.9	25.1	25.4	19.2
1963	1.1	-7.1	1.2	8.7	14.9	18.8	25.1	27.8	26.8	22.5
1964	-3.7	1.8	1.5	5.3	14.2	20.8	23.2	28.2	24.2	20.9
1965	-0.8	-0.2	-0.5	1.2	14.9	20.9	23.2	25.9	25.1	19.6

APPENDIX H

MONTHLY MEAN MAXIMUM TEMPERATURES (°F)

	December	January	February	March	April	May	June	July	August	September
1950	44.2	40.8	49.3	52.0	63.4	77.5	86.2	81.1	82.7	79.4
1951	41.1	41.4	45.7	50.2	60.5	76.4	80.3	86.6	88.8	75.3
1952	38.9	44.7	50.6	48.5	65.1	77.3	95.1	94.9	92.6	88.2
1953	45.6	42.0	51.1	57.4	63.9	75.9	94.5	92.8	91.1	87.8
1954	48.2	40.2	58.4	53.5	74.8	72.3	88.3	99.5	93.5	90.8
1955	40.5	41.3	38.5	56.5	76.2	79.4	82.1	97.0	95.5	87.3
1956	47.5	36.1	44.3	59.3	68.2	83.0	90.3	93.4	94.3	91.6
1957	50.8	34.8	47.6	55.0	62.4	74.4	84.8	93.8	93.7	78.1
1958	41.9	42.0	37.3	44.4	66.0	79.5	85.9	87.2	89.3	81.3
1959	50.0	34.7	42.0	58.6	67.0	78.3	87.5	87.8	94.4	82.1
1960	42.1	38.2	36.5	40.1	70.0	77.2	83.7	87.5	92.1	84.6
1961	35.5	44.4	47.3	55.5	64.7	72.1	83.8	90.8	87.6	76.8
1962	43.7	34.1	43.6	51.7	68.4	86.6	83.8	88.4	91.3	76.5
1963	36.1	29.1	46.9	60.5	71.9	76.7	89.1	93.5	92.4	84.0
1964	40.8	48.1	46.7	55.1	69.4	80.7	89.7	94.8	86.7	80.7
1965	50.4	43.7	43.4	46.3	72.3	81.5	84.7	89.7	89.8	78.2

APPENDIX I

MONTHLY MEAN MAXIMUM TEMPERATURES (°C)

	December	January	February	March	April	May	June	July	August	September
1950	6.8	4.9	9.6	11.1	17.4	25.3	30.1	27.3	28.2	26.3
1951	5.0	5.2	7.6	10.1	15.8	24.7	26.8	30.3	31.6	24.0
1952	3.8	7.0	10.3	9.2	18.4	25.2	35.0	34.9	33.7	31.2
1953	7.6	5.6	10.6	14.1	17.7	24.4	34.7	33.8	32.8	31.0
1954	9.0	4.6	14.7	11.9	23.8	22.4	31.3	37.5	34.2	32.7
1955	4.7	5.2	3.6	13.6	24.6	26.3	27.8	36.1	35.3	30.7
1956	8.6	2.3	6.8	15.2	20.1	28.3	32.4	34.1	34.6	33.1
1957	10.4	1.5	8.7	12.8	16.9	23.6	29.3	34.3	34.3	25.6
1958	5.5	5.6	2.9	6.9	18.9	26.4	29.9	30.7	31.8	27.4
1959	10.0	1.5	5.6	14.8	19.4	25.7	30.8	31.0	34.7	27.8
1960	5.6	3.4	2.5	4.5	21.1	25.1	28.7	30.8	32.3	29.2
1961	1.9	6.9	8.5	13.1	18.2	22.3	28.8	32.7	30.9	24.9
1962	6.5	1.2	6.4	10.9	20.2	30.3	28.8	31.3	32.9	24.7
1963	2.3	-1.6	8.3	15.8	22.2	24.8	31.7	34.2	33.6	28.9
1964	4.9	8.9	8.2	12.8	20.8	27.1	29.2	34.9	30.3	27.6
1965	10.2	6.5	6.3	7.9	22.4	27.5	29.3	32.1	32.1	25.7

APPENDIX J

MONTHLY MEAN MINIMUM TEMPERATURES (°F)

	December	January	February	March	April	May	June	July	August	September
1950	16.2	16.8	22.5	28.0	38.4	52.5	61.8	60.7	61.0	53.3
1951	18.0	16.0	22.3	25.0	39.4	53.1	58.0	65.3	65.7	52.6
1952	16.9	18.5	26.2	26.2	38.4	49.7	68.3	64.9	63.7	51.6
1953	23.2	19.0	24.0	32.5	38.2	51.8	68.7	65.6	63.6	53.9
1954	23.3	15.3	29.4	27.7	46.6	47.5	65.0	69.9	68.9	61.6
1955	18.9	20.0	17.5	27.6	47.1	54.0	59.6	71.8	65.7	59.2
1956	24.0	14.8	22.1	28.9	37.7	56.2	63.6	67.2	67.4	56.2
1957	26.6	15.3	26.0	31.9	43.0	52.4	60.7	70.5	66.2	52.2
1958	20.3	20.6	18.0	27.8	40.6	53.5	60.8	64.6	64.4	58.1
1959	26.4	13.4	21.8	33.2	41.5	56.0	63.3	63.1	70.2	55.8
1960	22.2	17.8	15.9	19.2	45.1	50.3	62.3	64.7	66.7	57.6
1961	14.4	15.3	25.8	34.2	38.1	50.6	61.3	66.1	63.9	52.2
1962	24.0	14.0	24.5	28.2	39.5	60.7	62.6	65.9	64.3	56.4
1963	14.7	9.5	21.4	34.8	45.8	55.0	66.3	70.6	68.0	60.9
1964	20.2	22.4	22.7	28.0	45.5	58.1	62.6	70.6	64.5	58.6
1965	30.1	19.6	18.5	21.9	45.5	57.8	62.4	67.5	64.3	56.1

APPENDIX K

MONTHLY MEAN MINIMUM TEMPERATURES (°C)

	December	January	February	March	April	May	June	July	August	September
1950	-8.8	-8.4	-5.3	-2.2	3.6	11.4	16.6	15.9	16.1	11.8
1951	-7.8	-8.9	-5.4	-3.9	4.1	11.7	14.4	18.5	18.7	11.4
1952	-8.4	-7.5	-3.2	-3.2	3.6	9.8	20.2	18.3	17.6	10.9
1953	-4.9	-7.2	-4.4	0.3	3.4	11.0	20.4	18.7	17.6	12.2
1954	-5.4	-9.3	-1.4	-2.4	8.1	8.6	18.3	21.1	20.5	16.4
1955	-7.3	-6.7	-8.1	-2.4	8.4	12.2	15.3	22.1	18.7	15.1
1956	-4.4	-9.6	-5.5	-1.7	3.2	13.4	17.6	19.6	19.7	13.4
1957	-3.0	-9.3	-3.3	-0.1	6.1	11.3	15.9	21.4	19.0	11.2
1958	-6.5	-6.3	-7.8	-2.3	4.8	11.9	16.0	18.1	18.0	14.5
1959	-3.1	-10.3	-5.7	0.7	5.3	13.3	17.4	17.3	21.2	13.2
1960	-5.4	-7.9	-8.9	-7.1	7.3	10.2	16.8	18.2	19.3	14.2
1961	-9.8	-9.3	-3.4	1.2	3.4	10.3	16.3	18.9	17.7	11.2
1962	-4.4	-10.0	-4.2	-2.1	4.2	15.9	17.0	18.8	17.9	13.6
1963	-9.6	-12.5	-5.9	1.6	7.7	12.8	19.1	21.4	20.0	16.1
1964	-6.6	-5.3	-5.2	-2.2	7.5	14.5	17.0	21.4	18.1	14.8
1965	-1.1	-6.9	-7.5	-5.6	7.5	14.3	16.9	19.7	17.9	13.4

APPENDIX L

MONTHLY TOTAL RAINFALL (INCHES)

	December	January	February	March	April	May	June	July	August	September
1950	1.17	0.05	0.53	0.60	2.00	3.97	3.56	13.58	3.72	0.30
1951	0.02	0.47	1.36	2.62	2.64	8.62	10.28	13.59	5.08	5.79
1952	0.29	0.24	0.30	2.97	3.37	3.12	0.25	0.95	3.21	1.09
1953	1.06	0.15	0.98	1.23	1.69	5.69	1.60	1.71	3.20	2.40
1954	1.13	0.05	2.06	0.58	2.06	4.33	5.23	1.95	4.91	1.18
1955	0.46	1.80	2.25	0.15	2.91	4.60	2.58	2.45	0.23	2.56
1956	0.35	0.51	0.33	0.16	1.40	2.05	3.84	5.07	3.61	0.12
1957	0.58	0.66	0.40	3.02	3.63	3.74	7.07	3.32	2.02	5.25
1958	0.88	1.27	1.45	2.23	1.48	2.17	7.57	12.39	3.91	7.56
1959	0.42	0.84	0.70	1.73	1.42	8.30	1.97	2.64	2.58	3.97
1960	0.48	1.45	2.31	1.32	2.94	2.77	4.17	5.35	5.76	2.83
1961	1.23	0.05	1.06	3.30	2.54	7.28	4.19	3.17	1.76	7.82
1962	0.75	0.83	1.06	2.07	1.14	5.98	4.40	2.86	4.50	4.56
1963	0.29	0.41	0.06	2.06	1.47	2.06	2.53	1.15	2.01	2.09
1964	0.15	0.33	0.58	1.52	4.41	2.52	5.12	3.64	3.22	2.03
1965	0.98	1.92	1.51	2.06	1.48	1.93	11.62	3.66	2.95	8.47

APPENDIX M

MONTHLY TOTAL RAINFALL (CENTIMETERS)

	December	January	February	March	April	May	June	July	August	September
1950	2.97	0.13	1.35	1.52	5.08	10.08	9.04	34.49	9.45	0.76
1951	0.05	1.19	3.45	6.65	6.71	21.89	26.11	34.52	12.90	14.71
1952	0.74	0.61	0.76	7.54	8.56	7.92	0.64	2.41	8.15	2.77
1953	2.69	0.38	2.49	3.12	4.29	14.45	4.06	4.34	8.13	6.10
1954	2.87	0.13	5.23	1.47	5.23	11.00	13.28	4.95	12.47	3.00
1955	1.17	4.57	5.72	0.38	7.39	11.68	6.55	6.22	0.58	6.50
1956	0.89	1.30	0.84	0.41	3.56	5.21	9.75	12.88	9.17	6.30
1957	1.47	1.68	1.02	7.67	9.22	9.50	17.96	8.43	5.13	13.34
1958	2.24	3.23	3.68	5.66	3.76	5.51	19.23	31.47	9.93	19.20
1959	1.07	2.13	1.78	4.39	3.61	21.08	5.00	6.71	6.55	10.08
1960	1.22	3.68	5.87	3.35	7.47	7.04	10.59	13.59	14.63	7.19
1961	3.12	0.13	2.69	8.38	6.45	18.49	10.64	8.05	4.47	19.86
1962	1.91	2.11	2.69	5.26	2.90	15.19	11.18	7.26	11.43	11.58
1963	0.74	1.04	0.15	5.23	3.73	5.23	6.43	2.92	5.11	5.31
1964	0.38	0.84	1.47	3.86	11.20	6.40	13.00	9.25	8.18	5.16
1965	2.49	4.88	3.84	5.23	3.76	4.90	29.51	9.30	7.49	21.51

EFFECT OF TEMPERATURE AND RAINFALL
ON SUMMER STEER GAINS OBTAINED ON
KANSAS BLUESTEM RANGE

by

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From 1950 through 1965, 2129 Hereford steers were observed on bluestem range near Manhattan, Kansas. The steer summer weight gains were correlated with existing temperature and rainfall conditions. Each month of the grazing season was analyzed separately by correlating that months 16 year average steer gain with temperature (mean, mean maximum and mean minimum) and rainfall averages of that month and the previous 5 months. Temperature and rainfall measurements of the previous 5 months were added 1 month at a time, resulting in the average of 2, 3, 4, 5 and 6 months temperature and the total of 2, 3, 4, 5 and 6 months rainfall measurements being correlated with the average steer gain for that month. Each of the climatic variables were analyzed for quadratic and linear effects.

The mean maximum temperature was the temperature measurement that had the highest correlation with each months steer gain. Results indicated that the environmental conditions during and 4 months previous to each months gain had a higher correlation with that gain than any of the other monthly climatic combinations.

The environmental conditions existing prior to the grazing season appeared to have the major effect on steer gains, since the previous 4 months climatic conditions had the highest correlation with that months gain. This would indicate that the climatic effect on gain was through climatic effects on forage production and quality.

Temperature, regardless of type of measurement, mean, mean maximum or mean minimum, tended toward a quadratic relationship with steer weight gain; while the relationship between rainfall and steer weight gain was linear.