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PERFORMANCE OF HEREFORD AND SANTA GERTRUDIS CATTLE ON AN ARID NEW MEXICO RANGE

by

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The dominant breed of beef cattle on the arid rangelands of southwestern United States is Hereford. Cattle with some Zebu (Brahman) breeding may be better adapted to the hot, arid environment of this area. Santa Gertrudis was selected as a breed in this latter category. An eight-year study of calf weaning weights and percentage calf crop weaned and a three-year study of blood composition of cows of these two breeds was conducted on the Jornada Experimental Range, 25 miles north of Las Cruces, New Mexico.

Study Area

The climate is typical of the arid phase of the semidesert grassland. There is an extremely variable precipitation, an abundance of sunshine, a wide range between day and night temperatures, and a low relative humidity. The average annual precipitation at Headquarters is 22.9 cm. and the average seasonal precipitation (July-September) is 12.7 cm. The average maximum temperature for January is 13.1 C and for July 34.8. The average minimum temperature for January is -5.3 C and for July 17.7 (Herbel and Nelson, 1966).

The major plant species are: burrograss (Scleropogon brevifolius Phil.); mesa dropseed (Sporobolus flexuosus (Thurb.) Rybd.); alkali sacaton (Sporobolus airoides (Torr.) Torr.); black grama (Bouteloua eriopoda (Torr.) Torr.); broom snakeweed (Gutierrezia sarothrae (Pursh) Britt and Rusby); leatherweed croton (Croton corymbulosus Engelm.; and soaptree yucca (Yucca elata Engelm.).

The total area used in the study of calf crop and calf weaning weights was 42,776 hectares. In the three-year blood composition study test cows of each breed were restricted to two pastures, one contained 1,068 hectares and the other 1,461 hectares.

Methods

A total of 291 grade Hereford cows and 46 grade Santa Gertrudis cows were in the herd in November 1, 1958. Management procedures included a low rate of culling of older cows and the addition of young cows to the herd in each of the eight years of the study. The maximum herd size was 307 Hereford cows and 127 Santa Gertrudis cows. The total number of cow-years was 2147 and 702 for the two breeds, respectively. The stocking rate varied from 40 to 90 hectares per cow. A salt-bonemeal mix was available near water. Small quantities of a ground concentrate mixture were fed during the very dry springs and early summers of 1961 and 1964 and to some of the thinnest cows in several of the other years. Bulls were with the cows from May 1 to October 1. Most of the calves were weaned in November.

Individual records for each cow included date of calving, sex of calf, calf weaning weight, and weaning date. A total of 1531 Hereford calves and 481 Santa Gertrudis calves were weaned in the eight-year period. The data for weaning weight in this paper include only 1092 Hereford calves and 327 Santa Gertrudis calves which were born in the 109-day period between February 21 and June 9 of each year and were weaned between ~~286~~ at 13 and ~~342 days old at weaning.~~ Dec 8 Data for each breed were analyzed separately. The least squares analysis of variance model (Harvey, 1960) for weaning weight included constants for year of data, age of cow, sex of calf, and regression of calf weight on age of calf at weaning. Data for two-year-old Herefords were omitted because only a few cows calved at this age . Also, data for 11-, 12-, and 13-year-old Herefords were combined. None of the Santa Gertrudis were more than 10 years old. The least squares model for percentage calf crop weaned included year of data and age of cow. Calf crop is the percentage of cows in the herd during the breeding season that weaned a calf in the following year.

Samples of blood were collected by venous puncture from test herds of 15 Hereford and 15 Santa Gertrudis cows every 56 days during a three-year period from December 1961 to September 1964. The cows in these test herds were born in 1959. Additional animals of each breed were stocked as necessary to achieve proper grazing use. Two pastures were used and each breed was pastured separately and was rotated between the pastures each year about November 1.

Hematocrit value (volume percent of packed cells) was determined using 15 ml. graduated centrifuge tubes; serum albumin and alpha, beta and gamma globulin were by paper electrophoretic fractionation using the hanging strip type of cell (Durrum) manufactured by Spinco Division, Beckman Instruments Inc.; and the following were by methods described by Hawk et al. (1954): hemoglobin by the acid-hematin method of Cohen and Smith, total serum protein using the micro-Kjeldahl apparatus, serum non-protein nitrogen by a modification of the Folin Wu method, plasma cholesterol by the method of Schoenheimer and Sperry, and serum calcium using the Clark-Collip modification of the Kramer-Tisdall method. Plasma phosphorus was by the A.O.A.C. (1960) method. Carotene and vitamin A were determined by the method of Sobel and Snow (1947).

The least squares analysis of various model (Harvey, 1960) for each of the blood values included breed, bleeding date, and the interaction of these two. Differences among means were subjected to Duncan's multiple range test (Steel and Torrie, 1960). The levels of many of the constituents were determined from samples collected on 19 dates. Certain of the values are for 15 dates, and phosphorus was for only 7 dates. Correlation coefficients among all blood values were computed within breed and date of bleeding. Data for 14 dates were used for 13 constituents. Data for only 7 dates were used for correlations involving calcium and phosphorus.

Results

Cow Production

The least squares constants for weaning weight are given in table 1. The differences among years were significant ($P<.01$) within both breeds. Year differences reflect the annual precipitation and quantity of forage available. Lightest weights were in the early and the late part of the study when precipitation was lowest. Heaviest weights were in 1962 when the growing season precipitation was 213 percent of average.

Young and old cows raised calves weighing less than middle-aged cows. The number of Herefords which calved at two years of age was very small and these data were omitted from the analyses. The heaviest Hereford calves were produced by four-year-old cows. The Santa Gertrudis calves raised by two-year-olds and by ten-year-olds weighed considerably less than calves from other ages of cows. The heaviest Santa Gertrudis calves were raised by six-year-old cows.

Steer calves weighed 6.8 and 13.0 kg. more than heifer calves for Hereford and Santa Gertrudis, respectively. Santa Gertrudis calves gained more rapidly from birth to weaning than the Hereford calves. The regression of weaning weight on age of calf at weaning was 0.36 kg. for Hereford calves and 0.65 kg. for Santa Gertrudis. The average adjusted weaning weights for 205-day old calves were 149.5 and 185.2 kg. for Hereford and Santa Gertrudis, respectively.

Least squares constants for percent calf crop weaned are given in table 2. All cows in the herd during the eight-year period were included. The average calf crop was 71.5 percent for Hereford and 70.4 percent for Santa Gertrudis. Calf crop was lower in years following years of low precipitation.

Table 1. Least squares constants for weaning weight, kg.[1]

Item	Breed	
	Hereford	Santa Gertrudis
α	75.7	52.0
Years		
1959	- 4.7	-20.6
1960	-29.7	-17.4
1961	3.5	13.3
1962	31.5	13.6
1963	6.7	4.2
1964	0.7	11.7
1965	- 1.1	- 1.6
1966	- 6.9	- 3.2
Age of dam, year.		
2	--	-33.6
3	- 2.0	8.0
4	10.6	8.4
5	5.6	9.3
6	6.6	15.0
7	3.4	4.3
8	- 1.2	2.8
9	- 4.0	5.0
10	- 3.0	-19.2
11,12,13	-16.0	--
Sex of calf		
Steer	3.4	6.5
Heifer	- 3.4	- 6.5
Regression of weaning weight on age at weaning	0.36	0.65

[1] Analysis of variance within breeds indicated that the differences were significant at $P<.01$).

Table 2. Least squares constants for calf crop weaned, percent.[1]

Item	Breed	
	Hereford	Santa Gertrudis
μ	71.5	70.4
Years		
1959	- 2.8	13.0
1960	- 4.7	9.8
1961	-25.0	- 7.2
1962	5.9	4.9
1963	13.0	1.3
1964	15.6	1.0
1965	3.5	-15.7
1966	- 5.5	- 7.1
Age of dam, year.		
2	24.7	- 8.8
3	6.0	1.5
4	-10.5	0.4
5	5.7	- 3.5
6	3.3	11.6
7	8.6	4.9
8	5.2	- 3.2
9	- 5.4	- 8.3
10	1.1	5.4
11	- 7.2	--
12	-45.9	--
13	14.4	--

[1] Year effects were significant (P<.01) within both breeds. Age of dam was significant (P<.01) only for the Herefords.

For example, the percentage calf crop was considerably below average in 1961 following the low precipitation and therefore lower quantity of forage available in 1960. Weaning weights were below average in 1960, but above average in 1961. Age of dam constants for calf crop were quite variable with no consistent trends indicated.

Hemoglobin

Mean hemoglobin values for each bleeding date within each breed are given in table 3. Santa Gertrudis cows had significantly ($P<.01$) higher levels of hemoglobin than the Herefords (13.7 vs 13.0). The levels at the bleeding dates were also significantly ($P<.01$) different, but the breeds varied together as the interaction of breeds and dates was not significant. The results of Duncan's multiple range test are indicated in the table by superscripts. During the first two years the highest hemoglobin levels were in the cool months; in the third year, there were only few significant differences among the dates. The initial level in December 1961 was high with a second peak in March 1963 and a third rise in June 1964. The low point was in August of each year.

Hematocrit Values

The average volume percent packed blood cells was significantly higher for the Santa Gertrudis than for the Herefords (44.7 vs 39.8), with high peaks in the winter and low points in the summer. The range in values was from 35.2 to 44.4 for Herefords and 41.0 to 47.9 for Santa Gertrudis. Dates were significantly different at $P<.01$, and the breed x date interaction was significant at $P<.05$. The breeds were different on all dates except September 1962 and December 1963.

Table 3. Least squares means for hemoglobin level for Hereford and Santa Gertrudis cows, gm. per 100 ml. blood[1].

Date	Breed		All Cows[2]
	Hereford	Santa Gertrudis	
December 20, 1961	15.7	15.8	15.8^{a}
February 13, 1962	14.2	15.2	14.7^{b}
April 10	13.5	14.6	13.9^{c}
June 5	13.6	13.7	13.7^{cd}
July 31	12.5	12.9	12.7^{e}
November 21	14.3	14.4	14.3^{bc}
January 15, 1963	13.4	13.8	13.6^{cdf}
March 12	14.9	15.8	15.4^{a}
May 7	12.5	13.7	13.1^{defg}
July 2	12.6	13.5	13.0^{defgh}
August 27	10.6	11.8	11.2^{i}
October 22	11.8	12.4	12.1^{ej}
December 17	12.8	12.9	12.8^{eghk}
February 18, 1964	12.5	13.3	12.9^{eghkl}
April 14	12.8	13.5	$13.2^{defghklm}$
June 9	12.8	13.9	$13.4^{cdfghklm}$
August 4	11.5	12.4	12.0^{jn}
September 24	11.7	13.3	$12.5^{eghjkln}$
Average	13.0	13.7	

[1] Analysis of variance indicated significance at $P<.01$ for breed and date, with the breed x date interaction non-significant.

[2] Date means having the same letter superscript are not significantly different ($P<.05$).

Plasma Cholesterol

Breeds ($P<.05$), dates ($P<.01$), and breed x date interaction ($P<.01$) were significant for level of plasma cholesterol. The average values were 138 mg. per 100 ml. of plasma for Herefords and 131 for Santa Gertrudis. The levels for both breeds were high in November 1962 and October 1964; however, additional peaks in April 1962 and May 1963 were recorded for the Herefords only. The differences were significant ($P<.01$) on these dates. The values were also higher for the Herefords in April and June of 1964, but these differences were not significant.

Serum Non-Protein Nitrogen

The 37.4 mg. of non-protein nitrogen per 100 ml. of serum for the Herefords was not significantly different from the 38.1 mg. for the Santa Gertrudis. Date of bleeding was significant at $P<.01$ and the interaction was significant at $P<.05$. Breeds were significantly different in seven of the 19 dates. On five of the seven dates the values were higher for Santa Gertrudis. The highest values were in August 1963; the lowest were in December 1963. Although variation was considerable, lowest values tended to be during the winter.

Serum Protein

The average serum protein was 7.41 mg. per 100 ml. in both breeds. Date and the breed x date interaction were significant ($P<.01$). Highest levels were in July, October, and September in the three successive years and appear to be related to the availability of high quality forage. Low values were in February, March-May, and February in these same years. The values for the Herefords were significantly higher in April 1962, with

those for the Santa Gertrudis significantly higher in May and August 1963.

Serum Albumin

The 3.87 gm. of albumin per 100 ml. serum for the Santa Gertrudis was significantly ($P<.01$) higher then the level of 3.69 gm. for the Herefords. Dates and the breed x date interaction were also significant ($P<.01$). The levels for both breeds varied together seasonally and were nearly equal at several dates until the last year when the levels for the Herefords were lower.

Serum Globulin

The total globulin level tended to be low in the winter when feed conditions were poorest and high during the summer. The Santa Gertrudis had significantly ($P<.01$) lower serum globulin levels than the Herefords (3.45 vs. 3.63 gm. per 100 ml. serum); but the breed x date interaction was also significant ($P<.05$). Levels of gamma globulin were lowest in February 1962 and rose to a peak in July 1962. The trend was downward to March 1963 followed by higher levels in late summer and decreasing again in winter 1964. The levels were apparently related to quality of grass in the pastures. Breed differences were not significant. The alpha globulin level was variable with no definite time trend although differences due to dates were significant ($P<.01$). The average beta globulin level was slightly higher ($P<.05$) for the Herefords. Lowest levels were in early 1962 with highest levels in late 1963 with no obvious seasonal trend related to forage quality.

Plasma Carotene

The level of plasma carotene was significantly higher ($P<.01$) for the Santa Gertrudis than for the Herefords (785 vs. 532 mcg. per 100 ml. plasma).

The seasonal lows were in February, January, and February in the three years. The lowest values were near 150 mcg. in February 1964. The peaks in 1962 were in June-July. In 1963 peaks were in May and in October. In 1964 the high was in September. These peaks were near 1200 mcg. for the Santa Gertrudis and 1000 mcg. for the Herefords. All values were apparently related to the availability of green forage.

Plasma Vitamin A

The average vitamin A value for the Santa Gertrudis was 91 mcg. per 100 ml. of plasma and was significantly ($P<.01$) higher than the 71 mcg. for the Herefords. Differences due to date were also significant at $P<.01$. The date x breed interaction was significant at $P<.05$ with the value for the Herefords significantly exceeding that for the Santa Gertrudis in June 1962, but the values for the Santa Gertrudis were higher than those for the Herefords in October 1963 and September 1964. Values were considerably higher in June 1962 than at any other time. The rises in May and October 1963 and in September 1964 were not as great as the rise in 1962, but occurred on the same bleeding date as the rise in plasma carotene.

Serum Calcium

The calcium content of blood serum was determined on only the first eight bleeding dates. Serum calcium was significantly ($P<.01$) higher in Santa Gertrudis than in Herefords (10.5 vs. 10.0 mg. per 100 ml. serum). The average high was in April and the average low was in October. The lowest value (9.4 mg) was for Herefords in June 1962.

Plasma Phosphorus

Concentrations of phosphorus in plasma of both breeds varied considerably. All sources of variation in the analysis of variance (breed, date, and breed x date) were significant at $P<.01$. The average phosphorus content of the plasma of Herefords was 4.4 mg. per 100 ml. and for Santa Gertrudis was 3.9 mg. On three dates values were significantly higher for Herefords; on one date the phosphorus value was significantly higher for Santa Gertrudis. Average lows were near 3.4 mg. High values were 5.0 to 5.5 mg.

Correlation Coefficients

Correlations among all blood values are given in table 4. Thirty-five of the 91 correlations listed were significant ($P<.05$). Some of the highest positive values were 0.77 between hemoglobin and hematocrit, 0.97 between protein and albumin plus three globulins and 0.49 between cholesterol and carotene. Highest negative values were between albumin and each of the globulins and between it and the total of the three globulins.

Summary

In eight years (1959-1966) the calf crop weaned by Hereford cows (2147 cow years) was 72% and by Santa Gertrudis cows (702 cow years) was 70% on the Jornada Experimental Range in southern New Mexico. Percent calf crop weaned was lowest in years following a year of low precipitation. The least squares model for weaning weight within each breed included constants for year of data, age of cow, sex of calf, and regression of calf weight on age at weaning. Year differences reflected the annual precipitation and quantity of forage available. Young and old cows raised calves weighing less

Table 4. Correlations among blood values

Item	Ht.	Chol.	Caro.	Vit.A	NPN	Prot.	Alb.	α gl.	β gl.	γ gl.	3 glob.	Alb.+ glob.	Ca[1]	P[1]
Hemoglobin	.77**	-.05	-.09	-.09	-.02	.35**	.37**	.00	-.06	.01	.04	.36**	.06	.06
Hematocrit		-.06	-.18*	-.09	-.05	.28**	.34**	-.03	-.05	.00	.00	.27**	.13	.01
Cholesterol			.49**	.11*	-.08	-.15**	-.04	-.03	-.03	-.11*	-.10*	-.13**	-.08	.18*
Carotene				.16**	-.02	-.10*	-.05	-.05	-.03	-.01	-.04	-.08	.03	.22*
Vitamin A					.07	.01	-.02	.06	.06	.00	.04	.02	-.01	.11
Non-protein N						.03	.03	-.01	.06	-.03	-.02	.01	.05	.16**
Protein							.48**	.23**	.34**	.51**	.57**	.97**	.22**	.09
Albumin								-.27**	-.23**	-.32**	-.41**	--	.17*	.13
α globulin									.18**	.14**	--	--	.11	.01
β globulin										.20**	--	--	.05	-.03
γ globulin											--	--	-.03	.00
3 globulins												--	.03	-.01
Albumin + 3 globulins													.17*	.10
Calcium														.04

[1] Includes 7 instead of 14 collection dates.

* P<.05

** P<.01

at weaning than middle-aged cows. Age of cows varied from 3 to 12 years for Herefords and 2 to 10 years for Santa Gertrudis. Steers outweighed heifers 6.8 kg. and 13.0 kg. for Hereford and Santa Gertrudis, respectively.

Samples of blood were collected by venous puncture from 15 cows of each of the two breeds every 56 days during a 3-year period. Determinations included hemoglobin, volume percent packed cells (hematocrit), plasma cholesterol, plasma carotene, plasma vitamin A, plasma phosphorus, serum calcium, serum non-protein nitrogen, serum protein, serum albumin, serum alpha globulin, serum beta globulin, and serum gamma globulin. Differences among bleeding dates were significant for all constituents. Greatest breed differences were the higher levels for hemoglobin and hematocrit value in the Santa Gertrudis and higher level of serum cholesterol in the Hereford cows. Values for certain constituents, such as non-protein nitrogen, serum protein, and total serum globulin were lowest during seasons of poorest forage quality. Thirty-five of the 91 correlations between blood constituents listed were significant ($P<.05$). One of the higher positive values was the correlation of 0.77 between hemoglobin and hematocrit. The highest negative correlation was -.41 between albumin and the total of the three globulins.

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