

A GENETIC STUDY
OF
THE HEREFORD CATTLE
IN
TEXAS COUNTY
OKLAHOMA

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By

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1. INTRODUCTION

This is a study of the breeding methods and practices used by the Hereford breeders of Texas County, Oklahoma in developing their purebred herds of Hereford cattle. The aims in this study are: to learn if inbreeding or other methods of breeding were practiced by the Hereford breeders in developing a high relationship among the Hereford cattle of the county, and how the inbreeding and relationship found in the Hereford breed here compared with that found in similar herd and breed studies and more especially how it compared with that found for the Hereford breed as a whole; to what extent the Hereford cattle of Texas County were being influenced by any one herd or family of the Hereford breed and which outstanding animals were affecting the breed in the county; to learn if the foundation stock of the Hereford herds in the county were obtained from a few select herds or if they were selected at random from Hereford herds over a large area; and the average length of life of the herds in the county.

II. REVIEW OF LITERATURE

A. A Brief History of the Hereford Breed

The original home of the Hereford breed of cattle is Herefordshire, a district in western England noted for its healthful climate, luxurious grasses, cattle and corn. Herefordshire is a district 38 miles long and 35 miles wide. The land here is divided into small farms, most of which are less than ten acre tracts. The climate is such that cattle are handled and fed out of doors almost exclusively. Steers are usually sold as feeders at 12 to 18 months of age and fed 60 to 90 days before being marketed, (1). The aim of the Herefordshire farmer in developing his cattle is to produce the greatest amount of high quality beef in the most economical way. History furnishes no record of the first breeder of Hereford cattle as a breed, (1). The name Hereford first applied to all the cattle of the district of Herefordshire, (4). Cattle here attained a standard of beef type and a reputation for prime beef as early as 1627.

Benjamin Tomkins, the elder, established a herd of Herefords at Canon Pyon in Herefordshire in 1742 and began developing his cattle as a distinct family, (1). He was breeding cattle at Canon Pyon in 1760 when Robert Bakewell, a breeder of livestock, at Dishley England began practicing inbreeding to produce refinement and fix type in his livestock, (6). Benjamin Tomkins was followed by his son Benjamin, the younger, who continued breeding the family of Herefords started by his

father. He practiced inbreeding extensively to establish uniform type and quality, (15). Tomkins, the younger, was the first Hereford breeder to keep a breeding record of his herd. Tomkins and John Price of Ryall, who obtained his breeding stock from the Tomkins' herd, are said to have bred a closed herd for 70 years with no ill effects, (15).

Other pioneer families helping to develop the Hereford cattle as a breed were the Hewers, who helped to establish color and markings in the breed; William Galliers; the Tully family; the Skyrme family and the Jefferies family, (8).

The first Hereford Herd Book was compiled by T. C. Eyton of Donnerville, England, in 1846, (12). It contained the names of 551 animals of record. The second volume appeared six years later with the names of 350 more bulls. It is impossible to state definitely when or how the white face as a distinct characteristic first made its appearance, (9). But it was a fixed characteristic in many herds as early as 1788, (8). The white face was first adopted as the standard for the breed about the year 1860.

B. Early Herefords in America

✓ Henry Clay, wishing to develop the Blue Grass region of Kentucky, purchased in 1817 a Hereford bull and two Hereford heifers in England and had them shipped to Kentucky where they were used in grading up the cattle of that state, (4). Herefords were imported into Virginia about this time by W. C. Rives, (9). And about the same time Admiral Coffin of the Royal English Navy presented the Massachusetts Society for the Promotion of Agriculture a Hereford bull and heifer to be used for grading up the cattle of that state, (1).

✓ 1840 marks the first importation of consequence of Herefords to the United States, when W. H. Sotham and Erastus Corning of Albany, New York, imported 21 Hereford cows and a bull, (8). This herd became the nucleus for the establishment of many new herds and Albany, New York became for a time the center of Hereford cattle breeding activity in the United States. ✓ Other important importations were made about this time into the state of Maine by H. C. Burleigh of Vassalboro, (4), and by Captain Phineas Pendelton of Searsport. ✓ John Humphries and Thomas Aston, moving to the United States from England, brought with them some Hereford cattle. They settled at Elyria, Ohio, later making a second importation of Herefords in 1860. Their herds in Ohio became the nucleus for breeding stock of Hereford cattle in the Middle West. ✓ William Stone, an early American Hereford breeder of Guelph, Canada, furnished early foundation stock for Hereford herds both in Canada and the

United States. Other early breeders of Hereford cattle in the United States were John Merryman of Baltimore, Maryland and Governor W. W. Crapo of Michigan. The Crapo herd in Michigan has become the oldest herd of Registered Hereford cattle in North America. Established in 1866, this herd is still in operation, (1).

There were but few cattle imported into the United States during the Civil War period and for several years following, but about 1870 there began an expansion of agriculture at which time more Hereford cattle were imported from England, and some of the most prominent Hereford herds were established in the United States from 1870 to 1880, (1). Importations of Hereford cattle to the United States from England between 1848 and 1886 numbered 3,704, (1). Of this number, 3,500 were imported from 1880 to 1886, (8).

Outstanding among the Hereford cattle breeders during the last 30 years of the 19th century were T. L. Miller, Beecher, Illinois; Charles B. Stuart, Lafayette, Indiana; Gudgell & Simpson, Independence, Missouri; C. M. Culbertson, Chicago, Illinois; Thomas Clark, Beecher, Illinois; W. S. VanNatta, Lafayette, Indiana; and Robert Hazlett, Eldorado, Kansas. Miller, Clark and Culbertson in their day were Herefords' greatest promoters. Miller was given the title of "John The Baptist" among Hereford Breeders. Miller's first sale of Hereford bulls going to the Range was in 1873. These bulls were sold to cattlemen of Colorado, who used them to improve

their range herds, (9). T. L. Miller compiled the first and second volumes of the American Hereford Record, which were accepted and purchased by the American Hereford Breeders' Association in 1883 and made a part of the records of the Association. Charles B. Stuart founded the Shadeland Farm herd of Herefords at Lafayette, Indiana, in 1880. His was the home of the imported bull, Garfield No. 7015. Gudgell and Simpson were both importers and breeders. They imported among many other Herefords the two bulls, Anxiety 4th 9904 and North Pole 8946. These two bulls were kept and used in their own herd. Anxiety 4th was used on the North Pole heifers with great success. Many bulls of this Anxiety breeding were sent to the Texas Panhandle and the High Plains for service on the range, (4). Gudgell's Hereford bulls were on the Oklahoma Panhandle Range, then known as No Mans Land, as early as 1879, (9). As the demand grew for Herefords of Anxiety breeding, sons and grandsons of Anxiety 4th were used in the Gudgell & Simpson herd to concentrate the Anxiety 4th blood under a careful method of selection and inbreeding. These results were so successful that the Anxiety strain of Herefords became more in demand in Texas, where 90 per cent of the beef cattle produced are Herefords, (4), than any other Hereford strain of cattle in the United States, (4).

In 1881 the Hereford breeders met in Chicago and organized the American Hereford Breeders' Association electing C. M. Culbertson of Chicago, President; T. E. Miller of Beecher, Illinois, Secretary; and Adams Earl of Lafayette, Indiana,

Treasurer. The Association was incorporated in 1883 and rules were passed for the recording of animals in the records of the Association. Because of the increasing number of imported Herefords into the United States about this time, the Association in 1886 made an assessment of \$100 on each imported animal entered in the American Hereford Herd Book, (4). This ruling was canceled in 1893, but it stopped for a number of years the heavy importation of Hereford cattle into the United States. The importation of Hereford cattle to the United States from 1893 to 1932 was 1,109 head, (1). The object of the American Hereford Breeders' Association is to protect the purity of the breed and promote the interests of the breed as well as those of the breeders.

Robert Hazlett began breeding Herefords in 1898. He selected for his foundation stock females of Anxiety breeding. All the younger females were by Wild Beau, a grandson of Anxiety 4th. Soon after starting his herd, Hazlett began practicing a method of selection and close breeding, (9). Using bulls of Anxiety breeding, he chose a method similar to that followed by Gudgell & Simpson, (16). By means of selection and close breeding, Robert Hazlett succeeded in building up one of the greatest, if not the greatest herd of Hereford cattle in the United States. This is evidenced by his winnings in the show circuits and the Hereford Register of Merit.

According to the 1930 census report, there are 127,508 head or 16.5 per cent more registered Hereford cattle in the

United States than all other breeds combined, (1). The greatest mission of the Hereford has been to improve the common herd.

C. Hereford Cattle Development in Texas County, Oklahoma

Texas County, Oklahoma, is a part of what was once called "No Man's Land". It existed as such from the time of the close of the Civil War until 1890 when it became a part of the Oklahoma Territory under the name of Beaver County, with the County seat at Beaver City. For many years it lay open as a free territory with no form of government except that administered by the ranchmen and the early settlers called "squatters". It is said that this territory was more thickly settled in 1886-87 than at the present time. Many of the squatters moved out and made the Run for land in the Oklahoma Opening of 1889 and later in the Opening of the Cherokee Strip in 1893, (5), leaving "No Man's Land" a home for the cattlemen until 1902. From 1902 to 1907, it was again settled by homesteaders. Upon the entrance of Oklahoma into the Union as a State in 1907, this land was divided into the three present counties of the Oklahoma Panhandle. Texas County, the center of the strip, has an area of 3,065 square miles, with a population in 1930 of 14,100 or 6.8 inhabitants per square mile, (11).

Unlike Herefordshire, England, the original home of the Hereford cattle, where only 16 per cent of the proprietors owned farms larger than 10 acres, Texas County farms and ranches

range in size from 160 acres (homesteads) to several thousand acres. Most Herefordshire breeders had but small herds of cattle. Texas County herds range in size from small herds to large herds of several thousand. Herefordshire is noted for its good grass and corn. Texas County is noted for its short grass (buffalo and gramma), wheat and sorghums.

This territory for more than half a century has been the home of high grade Hereford cattle. Hereford bulls of Gudgell breeding were used by Towers and Gudgell, owners of the OX Brand, along the Cimarron River in what is now Beaver County as early as 1879, (9).

The first herd of purebred hereford cattle in Texas County was brought there in 1906 by B. F. Rarick. This herd consisted of 27 purebred Hereford cows, a herd bull and two young bulls. Most of the 27 cows of this herd had been sired by Lord Briton 76447, a son of Ancient Briton 55749. On the dam side, some were of Anxiety breeding; the others traced back to Goodgrit 68779, to Corrector 48976 and to Washington 22615. B. F. Rarick was a breeder of purebred Herefords in Grant County, Oklahoma, before moving to Texas County, where he continued the breeding of purebred Herefords until his death in 1918. His sons continued his work with Herefords after his death until 1925.

James K. Hitch established in 1885 on Coldwater Creek one of the first ranches in "No Man's Land" with Henry C. Hitch, (23), son of James K, as its present owner, it remains among the important ranches in Texas County and has long been the home of high grade and purebred Hereford cattle. Henry C.

made his first purchase of purebred Hereford cows in 1912, although purebred Hereford bulls had been used previously. His herd from 1912 to 1930 varied in numbers from 500 to 3,500 head of purebred and high grade Hereford stock. From 1912 to 1926, when he quit registering cattle, he recorded more than 600 females and probably a like number of bulls in the American Hereford Breeders' Association. Many bulls from this herd have been used to improve the cattle herds in the Oklahoma and Texas Panhandles and the adjoining range states.

Because of the successes met with by Anxiety bred bulls on the range, Hitch was interested in developing a more or less highly related group of Anxiety bred Herefords by using bulls of Anxiety breeding. However, he did no inbreeding. Herd sires were not closely related as a group. Ten herd bulls sired all his registered Hereford cattle during the period from 1912 to 1926. Outstanding among them was the bull Debitola 70th, who sired 102 of the recorded females, (23).

George Hitch, a younger son of Jas. K. Hitch and brother of Henry C., was born on the Hitch ranch in Texas County, Oklahoma. He is a cattleman and rancher living on his ranch on Coldwater Creek in Texas County and has dealt in high grade and purebred Hereford cattle most of his life.

Near Eva, in the western part of Texas County, D. V. Norris began the breeding of purebred Herefords in 1916 continuing in the business until 1935. Mr. Norris went into the purebred business with the idea in mind of improving his herd and raising good market cattle. He purchased his herd bulls from different herds making his selection for herd bulls from the

standpoint of pedigree and price. He became interested in and practiced close breeding after 1927 with good results. Norris considers Domino Herefords the best and concentrated on that line of breeding after 1927, (23).

J. T. Hughes, a Hereford breeder now retired and living in Guymon, Oklahoma, first purchased a herd of purebred Herefords about 1916. He was breeding high grade Herefords at the time. Hughes kept and bred purebred Herefords for only four years during which time he was known as one of the most prominent breeders in the County. As a financier, Mr. Hughes knew the value of advertising and practiced its use. He used three herd bulls while in the purebred Hereford business and was interested in breeding Herefords from a financial standpoint with breed improvement as a secondary consideration. He developed his herd by choosing sires within a selected strain. In selecting his sires, he considered price, individuality and pedigree. Hughes believes that the Hereford breeders of Texas County were more interested in selecting individuality than pedigree and that there was a lack of advertising done by the breeders of the County. Mr. Hughes was the first Hereford breeder in Texas County to pay \$1,000 for a herd bull. This sum was paid for Generous Alvin 540194, who carried some of the blood of both Anxiety and Wilton strains. Generous Alvin proved a worthy sire. He was sold in 1920 along with the rest of the Hughes herd to B. B. and E. O. Childers of Guymon, Oklahoma, where he was continued in use as a herd sire for a number of years, (23).

B. B. and E. O. Childers began the breeding of purebred Herefords about 1918. After their purchase of the Hughes herd of Herefords in 1920, they carried on breeding activities extensively until about 1929. Two prominent herd sires, Generous Alvin 540194 and Beau Best 8th 1122679 were used in this herd.

The registered herd of Herefords kept by the Panhandle A. & M. College at Goodwell, Oklahoma, has never been as large as some of the private owned herds of Texas County, but it has probably had more influence over the Hereford breed in the county than any other one herd. This has been done by bulls being sold locally to the cattle breeders of the county over a long period of time. Bulls used in this herd have been Maple Lad 90th 567961, Beau Franklin 10th 689720, Mischief Mixer 24th 1179212, and Hazford Tone 25th 1626153.

Hereford Breeders of Texas County From 1906 to 1930

Breeder	Address	Began Breeding	Stopped Breeding	Still Breeding
Bay, Shirley E.	Guymon, Okla.	1921	1922	
Beasley, P. S.	Eva, "	1923		1930
Boaldin, B. W.	Elkhart, Kan.	1918	1926	
Bratton, L. E. Sons	Guymon, Okla.	1921	1929	
Byers, J. C.	Guymon, "	1921	1927	
Calvert, P. P.	Optima, "	1921	1929	
Childers, B. B. & E. O.	Guymon, "	1918	1928	
Dencker, Chris	Eva, "	1917		1930
Elliot, W. C.	Tyrone, "	1916	1921	
Fast, D. D.	Hardesty, "	1917		1930
Hitch, George	Guymon, "	1921	1925	
Hitch, Henry C.	Guymon, "	1912	1926	
Hughes, J. T. & C. O.	Guymon, "	1916	1920	

Johnson, W. R.	Eva, Okla.	1920	1924	
Mueller, Louis	Guymon, "	1921	1929	
Mueller, W. C.	Guymon, "	1923	1925	
Norris, D. W.	Eva, "	1916		1930
Panhandle A. & M. College	Goodwell "	1918		1930
Phillips, R. S.	Guymon, "	1923	1925	
Rarick, B. F. & Sons	Guymon, "	1906	1925	
Scranton, L. L.	Optima "	1920	1923	
Speakman, Bros.	Tyrone, "	1916	1923	
Spitzer, A. E.	Guymon, "	1916	1928	
Stamper, C. M.	Guymon, "	1920	1924	
Stone, J. R.	Texhoma, "	1917		1930
Wright, Paul	Optima, "	1919	1929	

D. Breed and Herd Studies

Sewall Wright in 1922 developed a method, (18), of measuring inbreeding and relationship of animals from their pedigrees. He used this method to analyze the Duchess family of Shorthorn cattle as bred by Thomas Bates. Wright's analysis shows that Bates bred the Duchess family of Shorthorns for 40 years or eight generations maintaining an inter se relationship ranging from 40 to 87 per cent with an average of 60 per cent. Wright also found that Bates had maintained an inbreeding coefficient of 40 per cent in the family throughout the 40 years. Wright in this study used complete pedigrees tracing them back to the beginning of the Coates Herd Book. He found that fresh blood when introduced into the herd was from bulls genetically as closely related as ordinary brother and sister. Their relationship was through the bull Favourite, who belonged to the Duchess family of Shorthorns, (19).

McPhee and Wright in 1925 developed and used an Approximate method, (20), for measuring the coefficient of inbreeding and

and relationship. This method is shorter than that used by Wright. It is practical when measuring larger groups with long pedigrees. They used this method in analyzing the Shorthorn breed from 1790 to 1920. In their analysis, they found that the coefficient of inbreeding rose 17 per cent from 1790 to 1810 and to 20 per cent by 1825. It rose more slowly after 1825, reaching 26 per cent in 1920. The coefficient of relationship among random animals of the breed when measured by their approximate method was found to be about 40 per cent. The analysis showed the Shorthorn breed to be 55 per cent related to the bull Favourite and 46 per cent related to Champion of England, (21). There appeared to be a tendency for families to form in the breed, but these did not persist long as they were soon merged into the breed again, probably through breed improvement.

In analyzing the British Dairy Shorthorn breed for inbreeding and relationship, McPhee and Wright found that inbreeding had been avoided, and that as a breed these Shorthorns do not differ materially in inbreeding from the entire British Shorthorn breed of 1920. Likewise, the average coefficient of relationship between the Dairy Shorthorns and the two foundation sires Favourite and Champion of England do not differ significantly from the coefficients of relationship between these sires and the British Shorthorn breed of 1920. They found in this analysis that the relationship of the Milking Shorthorns to each other and to random animals of the breed and to animals of the whole Shorthorn breed were similar to the average relationship found between random

Shorthorns of the entire Shorthorn breed, (22).

The British Dairy Shorthorns appear to be a group of the breed selected for dairy qualities and to have been selected from such diverse blood lines as to be equivalent to a random selection from the Shorthorn breed as regards their inbreeding as well as their relationship to Favourite and Champion of England and their relationship inter se. Results from Wright and McPhee's analysis indicate a wide if not wholly random distribution of the genetic potentialities for high milk production throughout the whole Shorthorn breed.

Lush, Holbert and Willham made a genetic study of the Holstein Friesian breed of cattle to find out the kind and amount of inbreeding that was being practiced in the development of the breed, to see if the breed was being developed as a single selected group or as distinct families, and to learn how important individual animals had been in the development of the breed as a whole. Using Wright and McPhee's Approximate method, they found that the coefficient of inbreeding rose to a little over four per cent in ten generations from 1881 to 1931 and that the average inter se relationship rose 3.4 per cent during the same time. The 1,000 pound fat producers and the All American and Reserve All American show winners were analyzed as a separate sample and when compared with the random sample of the breed taken at corresponding dates showed less inbreeding than the random sample of the breed. The breed was found to have been influenced more by the cow De Kol 2nd than by any one individual in the breed.

She was found to be a great grandmother to the breed with almost all the relationship being direct. The generation intervals were found to be about 4.5 years, (7).

Fowler, (3), made a genetic study of the Ayrshire breed of cattle to learn the part contributed by inbreeding and to learn if any relation exists between inbreeding and productivity. He used McPhee and Wright's Approximate method in figuring the inbreeding coefficient for the breed and Wright's Long method in figuring the inbreeding coefficient for the high milk producing cows. His study covered the period of time from 1877 to 1927 with samplings taken at five year intervals. He found that the Ayrshire cattle possessed a mixed ancestry of Teeswater and Holstein graded up; that the inbreeding coefficient for the breed had increased about 5.3 per cent from 1892 to 1927, which was slightly more than that found for the Special class; and that no detrimental effect on milk production was shown by inbreeding, (15).

Willham in 1935 analyzed the Hereford breed of cattle in the United States to learn what part inbreeding had played in the development of the breed; whether the breed was developed as a single homogeneous group of related animals or whether it had developed through definite families; if certain animals had influenced the breed more than others; whether different practices were followed in developing the Herefords which win fair and show classes and the average animals of

the breed; to learn how much influence individual foundation animals have had on the breed at the present time and if these foundation animals were bred by a few or by many breeders. He used both Wright's Long method and Wright and McPhee's Approximate method for measuring coefficients of inbreeding and relationship. Using 1860 as a base date, samples were taken at 10 year intervals from 1870 to 1930. Willham's analysis, (15) showed that the Hereford breed had lost about 8 per cent of its heterozygosis from 1860 to 1930 during 12.8 generations. The loss of heterozygosis was 0.62 per cent per generation with generation intervals averaging 5.4 years. The coefficient of inbreeding shows there was a tendency toward family formation with the families soon being used for grading up the rest of the breed. There was a tendency for the inbreeding to decrease and the inter se relationship to increase following periods of expansion. The inbreeding was little more than would be expected from random mating.

The three bulls, Anxiety 4th 9904, Don Carlos 33734 and Beau Brummel 51817 were found to have a high relationship to the breed. Beau Brummel was found to be a grandsire to the breed in 1930. Don Carlos nearly a grandsire and Anxiety 4th was 18.5 per cent related to the breed in 1930. Special groups as prize winners and Register of Merit animals had a higher coefficient of inbreeding than did those of the random sample. They were also more highly related to Anxiety 4th than were those of the random sample, while their inter se

relationship was similar. The tendency for family formation seemed about equal in both samples. It was found that 20 breeders in England were responsible for 80 per cent of the foundation animals of the Hereford breed and that 38 per cent of the foundation animals were bred by only three breeders, (15).

The following table shows the inbreeding and inter se relationship coefficients at ten year intervals as found by Willham, (15), in his genetic study and analysis of the Hereford breed in the United States:

Table I. Inbreeding and Inter Se Relationship Coefficients.

Year	Number of pedigrees sampled	Inbreeding Coefficients		Inter se relationship
		actually found	expected from inter se relationship	
1870	130	1.2	0.7	1.4
1880	500	2.9±0.5#	1.1	2.1±0.5#
1890	500	3.4±0.6	1.3	2.6±0.6
1900	500	2.7±0.5	2.6	5.2±0.7
1910	500	4.9±0.7	2.7	5.3±1.0
1920	500	4.6±0.8	3.7	7.1±1.1
1930	500	8.1±0.8	4.6	8.8±1.2
R.O.M.	111	10.0±0.9	7.7	14.2±2.3
1920 S	211	7.8±1.3	5.3	10.0±2.0
1930 S	207	17.3±1.8	9.5	17.3±2.5

The figures # following the ± signs are standard errors.

Winchester, (16), in 1938 made a genetic study of the Hereford herd of cattle as bred by Robert Hazlett of Eldorado, Kansas, to learn if inbreeding had been used in the development of Hazlett's Herefords and to learn if certain animals had influenced this herd more than others. He used the methods of Wright and McPhee. Winchester in his analysis included all the animals recorded by Hazlett in the American Hereford Breeders' Association. His sampling dates were of seven year intervals beginning in 1900 and ending in 1936. He used 1880 as a base date for his study.

The coefficient of inbreeding for the group was in 1900 7.7 per cent or about 5 per cent greater than that for the Hereford breed as a whole at that time. This would show that Hazlett's herd was about 5 per cent less heterozygous than the average Hereford to start with. The inbreeding coefficient increased 7.3 per cent in this herd from 1900 to 1936 representing a decrease in heterozygosis of about 1.15 per cent per generation. As the decrease in heterozygosis in the Hereford breed was less than one per cent per generation, this shows the gene fixation in the Hazlett herd slightly greater than in the Hereford breed. The coefficient of inbreeding was about half the coefficient of relationship, which was maintained at about 29 per cent. The Hazlett herd in 1936 was 25 per cent directly related to Beau Brummel 51817 and to Bocaldo 6th 464826. This shows these bulls to be as closely related to the herd as grandsires.

Winchester found that Hazlett practiced selection and linebreeding in developing his herd of Hereford cattle, (16).

III. THE INVESTIGATION

A. The Method of Procedure

1. Coefficient of inbreeding:

The methods used in this analysis were developed by Wright, (17 - 18), in 1922 and by Wright and McPhee, (20 - 21), in 1925. Their formulas measuring the coefficient of inbreeding, measures that per cent of heterozygosis existing in the foundation animals that has probably been lost as the result of inbreeding.

The primary effect of inbreeding is to lower the percentage of heterozygosis in the population. Inbreeding also promotes the formation of families, (6). Breed studies show most of the breeds to be losing from about one fourth to one half of one per cent of their heterozygosis per generation, (6).

Wright's formula for figuring the coefficient of inbreeding is: $F_x = \sum [(1/2)^{n+1} + 1 (1+F_a)]$. F_x represents the inbreeding coefficient of the animal x. The Greek symbol \sum means "the sum of." n represents the generations from the dam to the common ancestor. One-half is a factor representing the chance at Mendelian segregation. It shows that with each segregation or generation the common ancestor is removed from the animal measured, the probability of its receiving the same genes as those of the common ancestor is halved. $(1+F_a)$ is a factor used to weigh the contribution made by the common ancestor, itself inbred.

2. Coefficient of relationship:

The coefficient of relationship is closely related to the coefficient of inbreeding. It measures the correlation between two individuals as x and y with respect to characters determined wholly by heredity and without dominance brought about by matings of relatives. The formula for coefficient of relationship is: $R_{xy} = \frac{\sum [(1/2)^{n+n'} (1+F_a)]}{\sqrt{(1+F_x)(1+F_y)}}$. In this formula R_{xy} is the coefficient of relationship between the animal x and the animal y. It may vary in value from 0 to 1. The Greek symbol \sum means "the sum of". n and n' represent the number of generations from x and y to the common ancestor along the lines of relationship. F_a represents the inbreeding of the common ancestor. $(1+F_a)$ is a factor used to weigh the contribution made by the common ancestor. F_x and F_y are the inbreeding coefficients of the two animals whose relationship is being measured, (20 - 21).

3. The Approximate method of calculating the coefficients of inbreeding and relationship:

Wright and McPhee, (20), in working out their Approximate method for calculating coefficients of inbreeding and relationship from livestock pedigrees followed the same principles applied in the previous formulae with the exception that they used random sample lines instead of complete pedigrees. In analyzing a breed it is first necessary to decide upon a base date and to then secure a fair sample of the animals to be

analyzed for the period of time covered by the analysis. After the sample is obtained, each individual of the sample with its sire and dam is tabulated after which a random line of ancestry is traced from each, the sire and the dam to the base date. To keep the results from becoming biased, it is necessary to use great care in keeping the pedigree lines random. The random selection may be made by the use of cards or coins. They should be well shuffled or shaken causing them to fall at random. After the random line pedigrees are tabulated they are then examined for any ancestral ties that may exist between the lines. An animal appearing in both lines of the pedigree constitutes a tie. The first tie appearing is the one that counts. Only one tie can be counted in a pedigree and each tie is given a value of $1/2$ or 50 per cent, neglecting the effect of an inbred common ancestor, who unless highly inbred itself will have little effect on the per cent of inbreeding of the population. The chance of an ancestor appearing as a tie diminishes $1/2$ with the tabulation of each generation on the pedigree. For example in the n th generation back of the sire in a regular pedigree there are 2^n ancestors and in the n th generation back of the dam there are 2^n ancestors. In the two line pedigrees the random pair of lines is only one pair of the lines of a $2^{n+n'}$ pairs of lines which might go back to a common ancestor making a tie. If the random pair of lines in a two-line pedigree is a fair sample of the pedigree and a tie is found in the pedigree the tie must be multiplied by $2^{n+n'}$, which allows for the ties missed through the use of the two line pedigree by the random method.

This gives an estimate of the inbreeding as if the pedigree was a whole pedigree. Thus it is seen that a tie between $n+n'$ is really only $1/2(1+F_a)$. This makes it unnecessary to count the generations back to the tie that exists where a tie is given the value of $1/2$ or 50 per cent, if the inbreeding of the common ancestor is not figured. The coefficient of inbreeding for animals measured by the Approximate method is the sum of all the ties found in the sample plus the contribution made by the inbreeding of the common ancestors divided by the number of animals in the sample. The random method can be used in figuring out the coefficient of inbreeding for the common ancestors, but it will be more accurate to use complete pedigrees with Wright's Long method.

The standard error for the percentage of ties may be calculated by the formula $\sqrt{\frac{pq \cdot F_x}{N \cdot p}}$. p represents the number of ties observed in the sample, q the number of pedigrees not having ties and N the total number of pedigrees in the sample. F_x represents the inbreeding for the group. $\sqrt{\frac{pq}{N}}$ gives the standard error for the percentage of ties so that it will apply to the inbreeding coefficient. This standard error gives a measure for the sampling error resulting from the use of incomplete pedigrees.

Using the Approximate method for calculating the coefficient of relationship of a random sample, the pedigrees of the sample are thoroughly and carefully mixed to make them as much of a random sample as possible. Only one line of one pedigree can

then be matched against one line of another pedigree, but there is a possibility of a tie for every pedigree with each pedigree being used but one time. Ties are given a value of 1, which is weighed by the factor $(1+F_a)$. The total number of ties in the random sample is then divided by the total number of pedigrees in the sample and then by the factor $\sqrt{(1+F_B)(1+F_B)}$ which is $(1+F_B)$ for the particular period. This gives the total per cent of relationship. The standard error for the coefficient of relationship may be calculated by the formula $\frac{\sqrt{pq}}{N} \cdot \frac{R_x}{p}$. This is the same as for inbreeding except that it is weighed by $\frac{R_x}{p}$. R_x represents the relationship for the group and p the number of ties observed.

The inter se relationship is an estimate of the relationship that existed at the particular periods between the sires and dams of animals of the sample. The formula for the inter se relationship is $\frac{\sum(1+F_a)}{N(1+F_B)}$. The Greek symbol represents "the sum of", $(1+F_a)$ the inbreeding of the common ancestor, N represents the number of pedigrees in the sample and $(1+F_B)$ the total inbreeding of the sample. The standard error for the coefficient of inter se relationship is found as above in the coefficient of relationship.

In calculating the relationship of a particular animal to the breed each appearance of the animal in the sample is given a value of 1. The total number of appearances is then divided by the number of possible appearances of the animal in the sample, which gives the direct relationship of the animal to the breed.

4. The Analysis

Wright and McPhee's Approximate method, (20), was used to calculate the inbreeding and relationship for the Hereford breed of cattle in Texas County, Oklahoma. Only females were used in the analysis. The Hereford breeders of Texas County recorded 1500 females in the American Hereford Breeders' Association from 1906 to 1930. From this population a sample of 300 animals was obtained by taking every fifth female recorded. Two-line pedigrees were used in the analysis and the sequence in the ancestral lines was determined by tossing coins. (1880), the birth date of Anxiety 4th 9904 was used

Table II. Sample two-line pedigree:

Sample No. 265	Mischief Lassie 3d	No. 1667150
	SIRE	DAM
Mischief Mixer 24th	1179212	Mischief Lassie 1436736
Sire	Dam	Sire
	526236	Dam
		1006232
	378179	689720
308177		566830
171349		386931
51817 XX		264843
33734		207148
	6932	51817 XX
		24629
		9549

as a base date for the analysis. After the 300 pedigrees were tabulated to the base date, they were then examined for ancestral ties. No attention was given to the name of the animal, the

name of the breeder or the name of the owner. For illustration one of the pedigrees used in this analysis is given below. This sample pedigree shows a tie existing with the number 51817, which is the number of the Hereford bull Beau Brummel.

The entire sample of 300 pedigrees was then divided chronologically into three groups of 100 pedigrees each and the coefficient of inbreeding and inter se relationship figured for each group. It required more years to obtain the first group of 100 animals, as they were recorded over the earlier years of the study when there were fewer herds and fewer cattle were recorded. The inter se relationship was then figured for the entire sample as a single lot after the pedigrees had been reshuffled and rematched and comparisons made between the number of ties found and when the sample was measured in groups of 100. This was done in part to test the accuracy of the measurement.

The foundation animals of the various Hereford herds in the county were studied to ascertain their source, inter se relationship and relative importance within the county group. Records of the herd sires used during the period from 1906 to 1930 were studied.

Personal interviews and questionnaires were used to secure more information concerning the aims and methods of breeding as practiced by the breeders of purebred Hereford cattle in Texas County during the years covered by this analysis. Following are the names of Hereford breeders of the county who furnished questionnaire information.

P. S. Beasley	Eva, Oklahoma	J. T. Hughes	Guymon, Okla.
B. W. Boaldin	Elkhart, Kans.	W. R. Johnson	Eva, "
Chris Dencker	Eva, Oklahoma	D. V. Norris	Eva, "
D. D. Fast	Hardesty, "	Louis Mueller	Guymon, "
Henry C. Hitch	Guymon, "	Paul Wright	Optima "

It is impossible at this time (1940) to get first hand information from all the Hereford breeders that have had a part in developing Hereford herds in Texas County from 1906 to 1930, the time covered in this Thesis. Some of the Hereford breeders have died, some have moved away, some were in the business for only a few years, while only five of those remaining are in the purebred business. Practically all herd records have been destroyed since the breeders have discontinued the recording of their purebreds.

IV. RESULTS

Texas County, Oklahoma, the area covered in this study, was the home of high grade Hereford cattle for a number of years before Oklahoma became a State. Hereford bulls of Gudgell breeding were used on the adjoining range in No Man's Land as early as 1879, (9).

1. Inbreeding and Inter Se Relationship

The coefficient of inbreeding apparently did not increase from 1921 to 1925. This agrees rather closely with the situation found in the Hereford breed as a whole by Willham, (15). The expansion of the breed around 1920 was likely responsible for this condition. The increase in the coefficient of inbreeding from 3 per cent in 1925 to 5.5 per cent in 1930 represents a 2.5 per cent decrease in heterozygosis taking place during the

Table III. Inbreeding Coefficients

Random lot	Time	Animals in a lot	Ties found	Inbreeding per cent
No. 1	1906-1921	100	6	3. \mp 1.18
No. 2	1921-1925	100	6	3. \mp 1.18
No. 3	1925-1930	100	11	5.5 \mp 1.55
Total	1906	300	23	3.83 \mp 0.39

last five years of the study. This decrease in heterozygosis indicates that there was a change taking place in the breeding methods applied in the county or that the per cent of inbreeding was increasing through the continued use of sires whose pedigrees traced to one family in the breed. These results correspond to

statements made by the breeders in their questionnaires, "that there was no inbreeding practiced by the earlier breeders in the county." The inbreeding coefficient of 5.5 per cent in 1930 is comparable to that found in some of the breed studies but is less than that of the Hereford breed found by Willham, (15), and that found by Winchester, (16) for Hazlett's Hereford herd.

Table IV. Inter se relationship:

Random lot	Time	Animals in a lot	Ties found	Inter se Relationship per cent
No. 1	1906-1921	100	4	4.71.98
No. 2	1921-1925	100	8	8.72.7
No. 3	1925-1930	100	8	8.72.7
Total	1906-1930	300	20	6.6671.43
*Total Lot	1906-1930	300	21	7.71.45

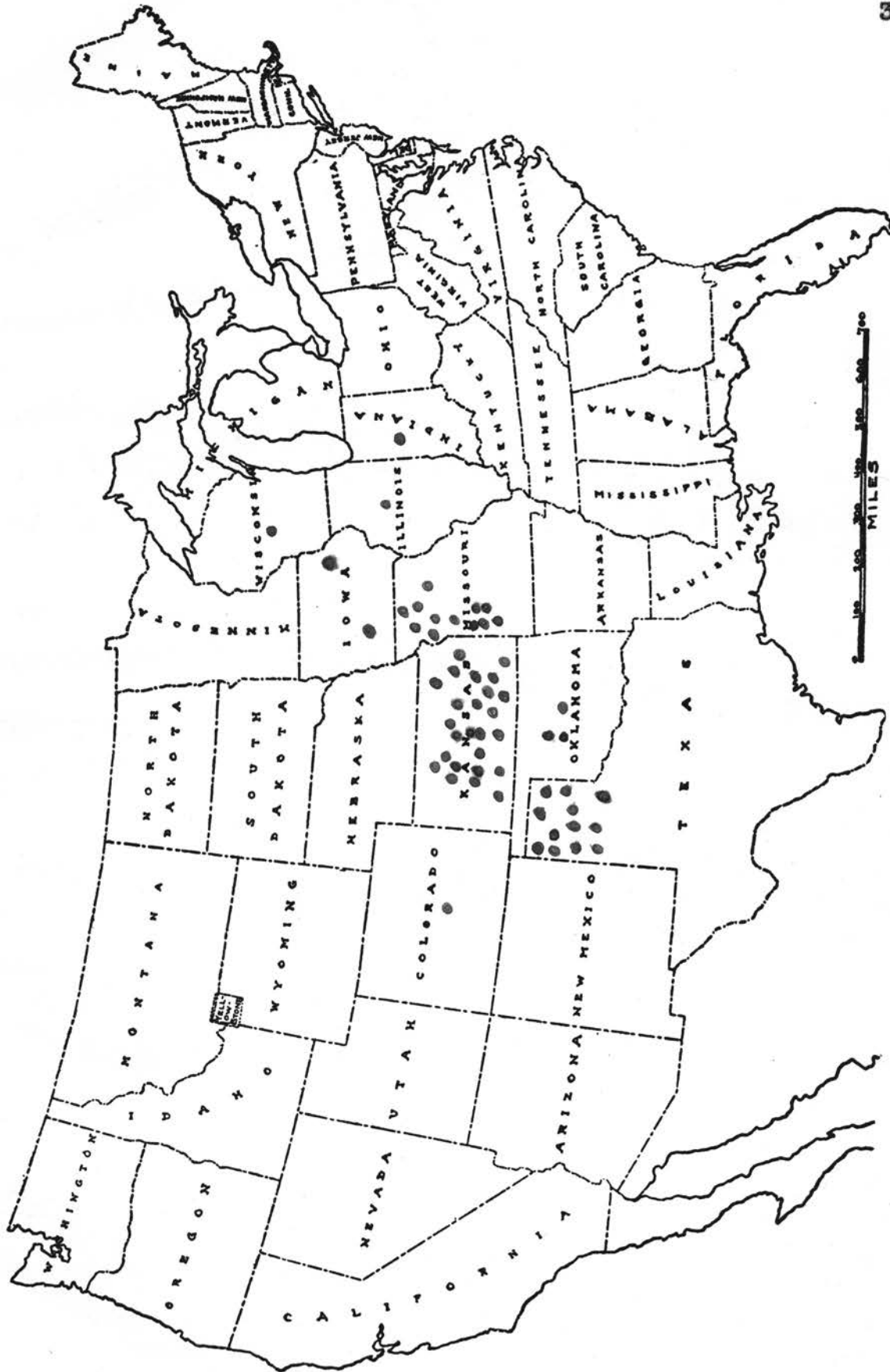
This measurement of the entire sample as a single lot was made after having been reshuffled and rematched at random.

The inter se relationship for the period from 1906 to 1921 was only 4 per cent but it increased to 8 per cent during the second period and remained at 8 per cent during the last period. The inter se relationship averaged 6.66 per cent for the entire period from 1906 to 1930. The entire sample when it was reshuffled and rematched at random as a test for accuracy gave an inter se relationship of 7 per cent. One more tie was found in the second measurement than in the first.

2. Foundation Animals of the Breed:

The earlier Hereford breeders of Texas County obtained their foundation animals from various Hereford herds in a number of different states of the Union. Few if any breeders

obtained their foundation cows from the same herd, so that the foundation animals were not closely related by pedigree. However some of the later breeders purchased their herd sires from the same Hereford herds. A few of the later herds were started from Hereford herds within the county and some of the later breeders used as herd sires, bulls purchased from Hereford herds in the county, which probably influenced the inbreeding coefficient causing it to be higher from 1925 to 1930. A map of the United States on the following page shows the location of the various Hereford herds that furnished foundation stock for the Hereford herds of Texas County.



Red dots indicate the sires and the black dots indicate the females.

Following is a survey of the foregoing map giving the state, location, breeder, the name and number of the bulls purchased out of the county and used as herd sires. Because of the greater number of cows used as foundation stock, only the state, location and breeder of the foundation cows is given to show the range in distribution of females used as foundation stock.

State	Location	Breeder	Herd-Sire	Number
Colo.	Littleton	Baker, G. W.	Mischief Mixer 24th	1179212
Ind.	Schneider	Black, John	Marcus Perfection	574071
Iowa	Kingsley	Shade, J. A.	Nebraska Fairfax	684638
Kansas	Belvue	Miller, Carl	Echo Lad 81st	636701
"	"	"	Echo Lad 170th	695679
"	Burns	Lathrop, H.	Brummel Prince	403152
"	Delphos	Burns, W. N.	Andrew	661387
"	Eldorado	Hazlett, R. H.	Hazeford Tone 25th	1626153
"	Emporia	Howe, J. H. & Son	Oxford	173961
"	Garrett	Fuller, N. J.	Teddy	232531
"	Hutchinson	Sifers, J. H.	Dutch	482383
"	Keats	Nelson, W. O.	Beau Donor	684959
"	Liberal	Pile, Bros.	Beau Stanway	1785369
"	Lost Springs	Cowman, James	Blake	382536
"	"	Shields, J. B.	Surrogate 7th	369098
"	"	"	Necklace	597778
"	"	"	Debitola 70th	597776
"	Ness City	Bowman & Co.	Generous Alvin	540194
"	Saffordville	Thomas, J. J.	Simpson Lad	435715
"	Shelbyville	Luce & Moxley	Prince Rupert 65th	452609
"	Wamego	Breymeyer, Henry	Dare 1st	678154
Missouri	Gallatin	Stigers, J. A. & Sons	Sylvanas	439491
"	Grandview	Wallace & Good	Beau Best 8th	1122679
"	Holden	Whitsett, R. L.	Bright Claremore 34th	1121744
"	"	"	Don Paragon Jr.	1427576
"	"	"	Bright Claremore 31st	1121741
"	Independence	Gudgell & Simpson	Marino	400388
"	Laclede	Jones, Bros.	Lincoln Lad 10th	359997

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State	Location	Breeder	Herd-Sire	Number
Missouri	Lees Summit	Norberg, Geo. B.	Prince Domino Lad 3d	1465555
"	"	Shawhan, D. Lee	Superior Anxiety 93d	1831054
"	Pleasant Hill	Smith, L. J.	Sir Stanway	804321
Oklahoma	Stillwater	A. & M. College	Beau Franklin 10th	689720
Texas	Conlen	Greenman, T. A.	Prairie Dog	555251
"	Stratford	Pronger, Bros.	Stratford Earl	509598
"	"	"	Jewell Jr.	599734
"	"	"	Bon Blanchard 38th	900928
"	"	"	Prince Blanchard	1089142
"	"	"	Blanchard C. 3d	1105444
"	Zulu	McCrea, Clara L.	Majestic 1st	641983
Wis.	Evansville	Robinson, J. C.	Maple Lad 90th	567961

State	Location	Breeder	Foundation females
Illinois	Millersville	O-Key, M. G.	" "
Iowa	Bellevue	Cornelius	" "
Kansas	Alta Vista	Perry, Bros.	" "
"	Delia	Seagrist, John A.	" "
"	Great Bend	Moses Bros., & Clayton	" "
"	Hartford	Evans, Thomas	" "
"	Lost Springs	Shields, J. B.	" "
"	Ness City	Bowman, J. J. & Co.	" "
"	St. Mary	Gideon, T. H.	" "
Missouri	Lamar	Egger, F. G.	" "
"	Warrensburg	McMurphy, L.	" "
Oklahoma	Dover	Puls, L.	" "
"	Jefferson	Rarick, B. F.	" "
Texas	Abra	Laycock, A. J.	" "
"	Childress	Johnson, J. W.	" "
"	Stanton	Eidson, A. C.	" "
"	Stratford	Pronger, Bros.	" "
"	Zulu	McCrea, Clara A.	" "

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3. Prominent Animals of the Breed:

Table V has been constructed to show the animals of the Hereford breed appearing most often in the random pedigrees, along with their birth dates, number of appearances and direct relationship to the Hereford breed in the county.

Table V:

Name	Registration number	Calved	Appearance on pedigree	Direct relationship per cent
Anxiety 4th	9904	1880	73	12.16
Beau Brummel	51817	1890	68	11.16
Don Carlos	33734	1886	64	10.66
Dowager 6th	6932	1877	52	8.66
North Pole	8946	1880	39	6.5
Belle	24629	1885	22	3.66
Grove 3rd	2490	1874	22	3.66
Beau Ideal 8th	9949	1876	18	3.00
Lamplighter	51834	1891	17	2.83
Beau Real	11055	1883	10	1.66
Don Juan	11069	1883	10	1.66
Militant	71755	1896	9	1.5
Anxiety 3rd	4466	1879	9	1.5
Donna	33735	1887	8	1.33
Columbus	51875	1891	7	1.16
Garfield	7015	1881	6	1.00

Anxiety 4th 9904, Beau Brummel 51817 and Don Carlos 33734 have the highest per cent of direct relationship to the Hereford breed in the county. These three bulls were also responsible for 13 of the 23 ties found as common ancestors in Table III.

4. Contribution of Sires in the County:

Ten of the 59 Hereford bulls used as herd sires in Texas County from 1906 to 1930 sired approximately half of the animals that were recorded in the American Hereford Breeders' Association from this county. Nine of the pedigrees of these ten bulls trace back to Anxiety 4th 9904. Of the 59 herd bulls recorded as sires of registered females in the county, Beau Brummel appears on 31 pedigrees and Lamplighter on 7. These two bulls were sons of Don Carlos and grandsons of Anxiety 4th.

The number of females sired by each of the more important herd sires used in the county are listed in table VI.

Table VI. Number of females recorded as having been sired by the following sires:

Hereford breeder	Sire	Registration number	Females recorded
Henry C. Hitch	Echo Lad 81st	636701	139
J. T. Hughes, B. B. & E. O. Childers	Generous Alvin	540194	120
B. B. & E. O. Childers	Beau Best 8th	1122679	109
Henry C. Hitch	Debitola 70th	597776	102
A. C. Rarick	Nebraska Fairfax	684638	78
Henry C. Hitch	Guymon	698327	77
Henry C. Hitch	Surrogate	228528	77

Hereford breeder	Sire	Registration number	Females recorded
B. F. Rarick	Dutch	482383	52
Panhandle A. & M. College, Henry C. Hitch	Beau Franklin 10th	689720	47
B. W. Boaldin Chris Dencker	Andrew	661387	43
Henry C. Hitch	Dare 1st	678154	38
B. F. Rarick	Sylvanas	439491	36
B. W. Boaldin	Blanchard B. 63rd	1219860	35
Henry C. Hitch	Surrogate 7th	369089	33
Henry C. Hitch	Panhandle Lad 11th	1345580	33
Henry C. Hitch	Echo Lad 32nd	1015920	32
L. E. Bratton & Sons	Donnis Blanchard	962123	28
Louis Mueller	Echo Lad 170th	695670	28
D. V. Norris	Bright Claymore 34th	1121744	28
J. R. Stone	Don Paragon Jr.	1427576	24
J. R. Stone	Sir Stanway	804321	22
D. V. Norris	Prince Domino Lad 3d	1465555	22
Panhandle A. & M. College	Maple's Lad 90th	567916	21
Panhandle A. & M. College	Mischief Mixer 24th	1179212	20

5. Questionnaires:

Questionnaire information obtained from ten of the Hereford breeders of Texas County, who bred Hereford cattle at some time during the period covered by this study, shows that nine of them avoided inbreeding and that one practiced inbreeding after 1927.

These breeders practiced individual selection and obtained when possible herd sires whose pedigree traced to Anxiety 4th in the top line. Their most effective herd sires were bulls of Anxiety breeding. Little cooperation existed among earlier breeders. With the organization of the Texas County Hereford Breeders' Association about 1922, Hereford breeders of the county cooperated more closely, operated as an organized unit and did more to advertise the Hereford cattle of the county.

6. Further Results:

The Hereford breed of cattle in Texas County was influenced by outstanding animals of the Hereford breed especially during the last few years of the study and most of the outstanding animals affecting the breed were of Anxiety breeding. Breeders in general selected bulls of Anxiety breeding for herd sires, however this influence was retarded by the avoidance of the practice of inbreeding.

7. Length of Life of the Hereford Herds in Texas County:

There were 27 breeders, who bred purebred Hereford cattle in the county at some time during the period covered by this investigation, but no one herd was in operation during the entire period from 1906 to 1930. The longest breeding period of any one purebred herd was 20 years, while the shortest was two years. The average length of life of a herd in the county was 8.7 years. Generation intervals were not figured in the investigation.

V. DISCUSSION

Selection and inbreeding are the two leading tools used by breeders of livestock. Selection has probably been used as a means of improving livestock since they were first domesticated. Our earliest records of inbreeding begin about 1765 when Robert Bakewell, a livestock breeder in England, first practiced it to produce refinement and fix type in the Longhorn breed of cattle. Bakewell acted on the theory that like begets like or the likeness of some ancestor, (6). Tomkins, Price and Hewer, pioneers among the early Hereford breeders of Herefordshire, England practiced selection and inbreeding in helping to develop the Hereford cattle as a distinct and separate breed. It can be seen that when a newly developed breed is small that it would be possible for one outstanding individual to have considerable influence upon the breed through its sons and daughters. But after a breed has become older and increased in numbers to thousands or millions, an animal or family to have any direct influence upon the breed must have many sons, daughters, and other relatives scattered in many prominent herds.

The Hereford breed in Texas County, Oklahoma is just a small part of the Hereford breed in general but it is larger than most individual herds and is composed of a group of breeders breeding purebred cattle in a small way in a small section near the center of what has been known as the Great Range Country of the United States, where the major industry has always been the raising and grazing of cattle for market.

Willham, (15), found a slow but continuous increase in the coefficient of inbreeding from 1870 to 1910 with a slight decrease in 1920 but a more rapid increase from 1920 to 1930. The increase from 1920 to 1930 being 3.5 per cent. The inbreeding coefficient of the Hereford breed in Texas County was 3 per cent from 1906 to 1921 and it did not change from 1921 to 1925, but it increased 2.5 per cent from 1925 to 1930. Winchester, (16), also found that the greatest increase in the coefficient of inbreeding in the Hazlett herd was from 1922 to 1929, when it increased 4.45 per cent and Fowler, (3), found that the inbreeding coefficient of the Ayrshire cattle increased faster after 1922. The analysis made by each of the above named men in their studies shows a decrease in the coefficient of inbreeding about 1920 but that it increased soon afterwards. This decrease seems to have been general and may have been brought about as a result of World War conditions about that time. It would be reasonable to expect a decrease in inbreeding during periods of widespread expansion. The coefficient of inbreeding of the Hereford breed in Texas County by averaging 3 per cent from 1906 to 1925 indicates that the Hereford breeders of this area were avoiding inbreeding to a greater extent than the average breeders through the United States. The increase of 2.5 per cent in the coefficient of inbreeding from 1925 to 1930 is comparable to the increase shown in Willham, (15), and Winchester's, (16), Hereford Analysis. Animals having the highest direct relationship to the breed

in this study, like those of the two Hereford studies mentioned, belonged to the Anxiety family. Bulls of this family used as herd sires would in time affect the inbreeding coefficient of the breed in the county, if their female offspring in turn were bred to and produced offspring from bulls of the same strain. A study of the pedigrees show that most bulls that were used as herd sires had some Anxiety breeding. The later herds whose foundation animals, both herd bull and cows, being purchased from herds within the county probably affected the coefficient of inbreeding and it was probably affected to a limited extent through the organized efforts of the Hereford breeders through their cooperation, advertising and selling together at regular breeder sales in the county. Inbreeding was not practiced but rather was avoided. The coefficient of inbreeding for the Hereford breed in Texas County increased, not as the direct result of breeders working cooperatively with that aim in mind, but more through the means of continuous selection of foundation sires of Anxiety breeding together with the cooperation of the later breeders.

The foundation animals of the early purebred herds in the county having come from different herds in several different states were possibly a fair representation of the Hereford breed but the relationship existing between them was slight. The inter se relationship was 4 per cent from 1906 to 1921. It increased from 4 per cent in 1921 to 8 per cent in 1930. The inter se relationship of 8 per cent in 1930 was about double that of inbreeding and was 0.8 per cent less than

Willham, (15), found for the Hereford breed the same year.

The numerous appearances of such prominent animals of the Hereford breed as Anxiety 4th 9904, Don Carlos 33734, and Beau Brummel 51817 in the random pedigrees shows that an effort was being made by some of the breeders to increase the relationship of their herds toward the Anxiety family of Herefords and that some of the inbreeding found was because of this method of selection. However, the direct relationship of these bulls to the Hereford breed in Texas County was less than Willham, (15), found their relationship to be to the entire Hereford breed.

Improvement of a breed by the use of unrelated sires must be done by selection. Selection is the basic tool used in animal breeding. It gives results that may be more or less rapid at first but slows down as a goal is approached. The effects of a sire begins to diminish as soon as his service is discontinued if unrelated sires are used each generation. This reduction amounts to $1/2$ the first generation, $1/4$ the second generation and continues likewise to decrease with each new generation. The contribution of those characters of a prominent animal in the breed or herd can best be retained in the herd and breed through a continuation of selection and inbreeding.

Breeding of livestock is one of the initial and fundamental occupations of man. Many breeds have been developed and improved to meet the economic demands of the public. The greatest improvement of the breeds have come, seemingly,

through the efforts and breeding methods applied by a few breeders. Their improved animals have been used as a standard of attainment for the breed. Sons and daughters of these prominent animals by being well distributed among the breed improve it by stamping the characters of their prominent parents in the breed. It takes time, study, experience, and a knowledge of livestock and breeding methods to develop a herd or breed of livestock of like characters highly desirable. In Willham's, (15), analysis of the Hereford breed, he found that only 102 animals were responsible for 84 per cent of the 1,000 ancestral lines in 1930, and that three of the earliest Hereford breeders bred the foundation animals in about 38 per cent of the 1930 ancestral lines. The breeders in this study were in business only a short length of time and were probably limited as to the knowledge of breeding methods, which with inexperience increased their breeding problems. It is thought that they could have cooperated and worked together as a unit to an advantage in improving their Herefords as a breed in the county and in promoting sales and creating a demand for their cattle elsewhere.

Inbreeding produces homozygous combinations of genes or like factors from both parents, investing the offspring with a double dose of the same thing. This double dose of the same genes has the same chance of being an unfortunate combination as of being a fortunate one. The vigor or fertility of the offspring may be affected by intense inbreeding practices or

the more desirable characteristics may be improved. Inbreeding brings to light family defects. But if practiced properly with the aid of careful selection, individuals and families of highly undesirable characteristics may be eliminated from the breed. This, however, is too great a task for the average breeder and will have to be left to wealthy breeders wishing to improve the breeds, or to some government agency established for that purpose. The method of selection as practiced by the Hereford breeders of Texas County is a slow but sure means of breed improvement.

VI. SUMMARY AND CONCLUSION

The breeding methods and practices of the Hereford breeders of Texas County, Oklahoma have been studied to ascertain what part inbreeding and other breeding practices have had in the development of the Hereford breed in the county.

Wright and McPhee's Approximate method used for calculating the coefficient of inbreeding and relationship from livestock pedigrees was used.

A sample composed of 300 pedigrees selected at intervals from the entire number of females recorded in the American Hereford Breeders' Association by the Hereford breeders of the county from 1906 to 1930 were used to measure the inbreeding and inter se relationship of the Hereford breed in the county.

The coefficient of inbreeding for the breed in this county was 5.5 per cent from 1906 to 1930. It increased fastest during the last five years of the investigation.

The inter se relationship was eight per cent during the period from 1906 to 1930. It increased four per cent during the last ten years of the investigation and was two and one-half per cent higher in 1930 than the coefficient of inbreeding.

The coefficient of inbreeding and inter se relationship was found to be similar to that found in other breed studies that covered this period of time.

The coefficient of inbreeding was three per cent from 1906 to 1925 showing that breeders in general were avoiding inbreeding and giving very little attention to the formation of families.

Animals having the highest relationship to the group were of Anxiety breeding and were Anxiety 4th 9904, Don Carlos 33734 and Beau Brummel 51817; father, son and grandson. The breed was 12.16 per cent directly related to Anxiety 4th and 11.16 per cent directly related to Beau Brummel, a grandson of Anxiety 4th.

No herd sire in the county had an outstanding influence on the breed. Most herd sires were obtained from Hereford herds outside of the county and but few of the herd sires used in the county came from any one herd.

The average life of a purebred Hereford herd in the county was 8.7 years while the life of individual herds ranged from two to twenty years.

The principal method practiced by the Hereford breeders of the county in developing their individual herds was selection. Preference was given to bulls of Anxiety breeding.

The organization of the Texas County Hereford Breeders' Association after 1920 resulted in closer cooperation among breeders and an increase in the inbreeding and relationship of the Hereford cattle as a group or breed in the county followed.

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