X-Rays of Lumbar Vertebrae as a Method for Detecting Carriers of Dwarfism

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Within recent years there has been an apparent decrease in the numbers of dwarf calves produced in beef cattle herds. This reduction has been largely the result of pedigree discrimination combined, in many cases, with an increased use of progeny tested sires. However, it must be recognized that dwarfism is still a problem and continues to be an important factor influencing breeders in their selection of breeding animals.

The most effective tool the breeder may use in combating dwarfism is progeny testing. Unfortunately, because of numbers involved, this method is limited to bulls. If no dwarf calves result from the mating of a bull to sixteen or more known dwarf-carrier cows, or twice that number of daughters of a carrier bull, the breeder can feel reasonably sure that the bull does not carry the dwarf gene. If only clean bulls are used, no dwarf calves will be produced even though the cow herd may include dwarf carriers. Although progeny testing is the most accurate method available, it is expensive and time consuming, and largely practiced only by the larger purebred breeders.

Pedigree selection has been the method most often employed by the average breeder. To be effective in controlling dwarfism, selection must be based on accurate pedigree information. In many cases such information is not available, and discrimination is based on rumor and hearsay. Pedigree selection under such conditions cannot be effective and can be very detrimental to the breed. Even when accurate dwarfism pedigree information is available, wholesale discrimination against certain lines of breeding reduces the selection pressure within the breed for other economically important production traits. This reduction is proportional to the fraction that the "dirty" bloodline comprises of the total breed population. Unfortunately, this has been a sizeable fraction in some cases, and has resulted in the loss of many desirable animals.

Further consideration of pedigree selection must lead to the realization that although many of the clean lines appear to have proven themselves, there is still the possibility that some lines may actually include dwarf carriers that have never been exposed. The increased use of progeny tested bulls decreases the possibility that these animals will be exposed, although they will continue to contribute the dwarf gene to the population. If pedigree selection is to be the basis for controlling dwarfism, such lines must be eliminated as rapidly as they are detected.

Efforts to eliminate dwarfism in beef cattle are still hampered by the lack of an accurate means of identifying carriers at a young age and at a relatively low cost. A method of this sort would enable breeders to discriminate against individual animals rather than entire lines of breeding.

A very extensive research program has been conducted at several Experiment Stations in an effort to develop such a diagnostic technique. One method that was proposed was based on differences observed in x-rays of the lumbar vertebrae of very young calves. The accuracy of this method has been extensively tested at the Oklahoma Station, as well as at several other Experiment Stations. The purpose of this report is to summarize the results to date and evaluate this method.

Procedure

A detailed description of the vertebral abnormalities believed to be characteristic of dwarfism and the testing procedures used are presented in an earlier Feeders Day Report (MP-48, pp 33-42). Briefly the procedure was to x-ray the lumbar region of the spine before the calf was one week of age. On the basis of their x-rays, the calves were classified as A (dwarf), B (predicted dwarf carrier), and C (predicted clean). Although all calves with B x-rays were predicted to be carriers, they were further classified as to degree of abnormality as MB (mild B, only slightly abnormal), IB (intermediate B, definitely abnormal), and XB (extreme B, extremely abnormal).

The necessity of obtaining the x-rays only on very young calves seriously hampered an early, complete evaluation of the technique. In most cases the true dwarfism genotype of the calf was not known, and could only be determined after the animals had reached sexual maturity and could be progeny tested. A tester herd of approximately 120 cows known to be carriers of the dwarf gene is maintained at Ft. Reno to progeny test young bulls whose dwarfism genotype has been predicted on the basis of the x-ray and other techniques. A few matings were made of normal heifers with a dwarf bull. This test not only enables one to partially test the genotype of the heifers, but all calves that result are known to be heterozygous. Unfortunately, it is not often easy to find a fertile, active, dwarf bull.

Results and Discussion

Although approximately 1,000 calves have been x-rayed at the Oklahoma Station since the beginning of this project, the true dwarfism genotype was known for only 58 calves. The x-ray classifications for these calves of known genotype are presented in Table 1.

Forty-four dwarf calves, thus known to be homozygous for the recessive dwarf gene, were x-rayed. Of this number, 42, or 95 percent, had the abnormalities typical of the dwarf and were classified as "A". The two calves that did not have the typical dwarf vertebrae were classified extremely abnormal "B". The abnormalities typical of the "A" classification appear to be specific for the dwarf, since no non-dwarf calf has ever been classified "A". Although an occasional dwarf would

Table 1.—Summary of x-ray classifications of all animals of known genotype for the dwarf gene. Data for Hereford and Angus combined. Ft. Reno 1955-57.

Genotype	No.	X-Ray Classification C	MB	IB	XB	A
Heterozygous						
By Progeny Test	7	2	0	2	3	0
One Parent Dwarf	7	1	1	3	2	0
Homozygous Recessive	44	0	0	0	2	42

be missed on x-ray, this method appears to be an accurate means of identifying a dwarf calf. This could be very important in cases of dead calves that cannot be definitely diagnosed as a dwarf on the basis of their appearance.

Only 14 animals heterozygous for the dwarf gene were x-rayed as calves. Eleven, or 78 percent, were predicted to be heterozygous on the basis of their x-rays. This level of accuracy of the x-ray method for predicting carriers of the dwarf gene is well below the level obtained from the combined data of all Experiment Stations that are working on this method. This pooled data reveals that there have been 187 known carriers x-rayed, of which 167, or about 90 percent, were classified as carriers on the basis of their lumbar x-rays. This pooled estimate is probably more reliable in evaluating the accuracy of the technique than is the limited data from any one station.

Table 2 is an estimate of how accurately the x-ray technique identifies animals that are free of the dwarf gene. Two years data from a grade herd at Ft. Reno, that is believed to be free of the dwarf gene, reveals that 77 percent of the calves were classified "C" and thus predicted free of the dwarf gene. This compares very closely to an esti mate of 80 percent predicted clean by all stations working with similar herds. This is the best estimate that can be obtained, but it must be recognized that such "believed clean" herds could carry the dwarf gene at a low frequency. However, until this is proven we must assume that the lines are clean, and use of the x-ray method would result in culling 20 percent of the clean animals of a line as suspected carriers.

Table 2.—Summary of x-ray classifications of calves produced in a herd believed to be free of the dwarf gene—1955-56.

No. Sires	No. Calves	Percent of All Calves in Each X-Ray Class C	MB	IB	XB	A
12	235	77.0	16.6	6.4	0	0

Most of the calves that have been x-rayed in this study could not be definitely classified into either the clean or carrier group. Thus, the data from these calves could contribute only indirectly to determining the accuracy of the method. Table 3 presents a summary of the x-ray classifications of calves produced by known carrier cows in 1956-1957. The data is broken down in groups based on the breed and x-ray classification of their sires. It is readily apparent that the distribution of x-ray classifications among the calves follows very closely the x-ray classification of their sire. Bulls with "B" x-rays sired a higher percentage of calves with "B" x-rays, and a lower percentage of calves with "C" x-rays than did bulls with "C" x-rays. If the bulls with "B" x-rays were carriers, the expected distribution of genotypes among their calves would be 25 percent dwarf-free ("C" x-ray class), 50 percent carrier ("B" x-ray class), and 25 percent dwarf ("A" x-ray class). If the bulls with "C" x-rays were dwarf-free the expected distribution of their calves would be 50 percent dwarf-free and 50 percent carrier with no dwarf calves. Except for the discrepancy in the dwarf classification, the observed ratios in each sire group in Table 3 fairly closely fit the expected. While no definite conclusions as to the accuracy of the x-ray technique can be drawn from these distributions, it is further evidence of the association between the x-ray classification and dwarfism genotype of a calf.

Table 3.—Summary of x-ray classifications of all calves from known carrier cows and sired by x-rayed bulls in 1956 and 1957.

Breed	X-Ray Class	No. Bulls	No. Calves	Percent of Calves in Each X-Ray Class				
				C	MB	IB	XB	A
Hereford	B	13	52	25.0	7.7	28.8	26.9	11.5
Angus	B	6	33	30.3	15.2	36.4	18.1	0
Hereford	C	8	46	45.7	21.7	21.7	6.5	4.4
Angus	C	6	38	60.5	13.2	23.7	2.6	0

What conclusions can be drawn as to the value of the x-ray technique as a method for combating dwarfism? The estimate as derived from the pooled data from all stations can probably be considered to be reliable estimates of the accuracy of the method under field conditions. These limits of accuracy are not considered high enough to recommend the method be used as a basis for merchandising cattle. Theoretically the method could be useful in early screening of prospective breeding animals in a problem herd. Selections based on x-ray classifications made by an experienced technician should eliminate a large percentage of the carriers, and significantly reduce the frequency of the dwarf gene in the replacements for the herd. However, under present conditions, the pedigree discrimination that would be encountered in attempting to sell breeding stock offers little, or no, incentive to a breeder to attempt to clean up a herd with a dwarfism history.

Summary

Data are presented on three years study of the x-ray technique for detecting carriers of the snorter dwarf gene. Approximately 80 percent of the dwarf carriers x-rayed as young calves at the Ft. Reno Station were correctly classified from x-rays of their lumbar vertebrae. It was also observed that 20 percent of the calves from a herd believed to be free of dwarfism were classified as carriers from their x-rays.

The x-ray method is not considered accurate enough to serve as a basis for merchandising beef cattle. It can be useful in early screening of prospective breeding animals in a problem herd. However, its practical application is limited by the pedigree barrier against animals from such herds.

Snorter dwarf calves have very characteristic abnormalities of the lumbar vertebrae that have never been observed in non-dwarf calves. Lumbar x-rays accurately identify a dwarf calf, and may be very useful to breeders in determining the dwarfism status of a doubtful calf.

Contributions of Nutrition Research to Animal Production

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Is the present-day animal nutritionist overly optimistic when he gazes into his crystal ball and predicts the effects of future discoveries upon animal production? If we look back over the past 60 to 70 years, we can readily see that at no time within this period was he optimistic enough in forecasting the enormous impact of nutritional discoveries on present-day animal production. These discoveries have made it possible for fewer farmers to produce more meat, milk and eggs upon fewer acres of land. But we must do better. When you sit down at your dinner table this evening, there will be over 35,000 more people to join you than there were at breakfast.

Important Past Discoveries in Nutrition

To better understand the importance of basic nutrition research, and to make some predictions of future happenings in this field, we must review some of the discoveries and concepts of the past that have greatly influenced the field of animal nutrition. Along these lines, let us consider the development of the purified diet concept and its effect on nutritional discoveries and important past discoveries in vitamin, protein and mineral nutrition.

1. PURIFIED DIET CONCEPT. In the year 1830 a British physician named William Prout stated that there were what he called