by Dan Moser

Updated Adjustment Factors and Genetic Parameters

While many Hereford breeders anxiously await the results of the semiannual North American Cattle Evaluation (NACE), jointly conducted by the American Hereford Association (AHA) and the Canadian Hereford Association (CHA), few likely give much thought to the methodology behind the evaluation. In the upcoming summer evaluation, in addition to the new data submitted since last fall, some changes will occur because of new adjustment factors and genetic parameters. These changes are a routine update that is done every five to 10 years, a regular maintenance of the genetic evaluation system to ensure that superior genetics in the breed are identified as early and as accurately as possible.

The goal of any genetic evaluation program is to correctly describe genetic differences between animals. Yet, the performance of animals is a result of both genetic and environmental factors. So, genetic evaluations must consider environmental differences between animals, leaving only the genetic factors that are reflected in expected progeny differences (EPDs). Such environmental factors are accounted for in three ways: adjustment factors, genetic parameters and contemporary grouping. In each case, these techniques are used to make sure all animals are fairly compared, to estimate their genetic values as precisely as possible.

The adjustments and parameters for the NACE for Herefords were last estimated 10 years ago for many traits. Since that time data quantity has increased dramatically, with growth measures increasing in number by 20% and ultrasound measures doubling in number. Quality of data has increased as well. For these reasons, a new estimation of adjustment factors and genetic parameters was appropriate, and this work was completed by the Agricultural Business Research Institute (ABRI) in April 2005.

The results were reviewed by AHA and CHA staff members, and their respective boards of directors. Both boards approved use of the new adjustment factors and parameters, and the changes will be implemented in the summer 2006 evaluation. Because of the increased quality and quantity of data used to estimate these adjustment factors and parameters, the new factors more accurately describe the current North American Hereford database and should result in even more accurate EPDs.

Some environmental factors are easily accounted for by mathematical adjustment equations. These factors are relatively constant across different farms and ranches. For traits measured at weaning or yearling time, calves will vary in age within a group. Adjustment factors are used to predict what the weight of each calf would be if they were all weighed at exactly 205 days of age, the standard age for adjusted weaning weights. Weights of calves younger than 205 days of age are adjusted up, while weights of calves older than 205 days of age are adjusted down.

Likewise, yearling weights, ultrasound measurements and scrotal circumference measurements are adjusted to a constant 365 days of age, to ensure all calves are fairly compared regardless of whether they are the youngest or oldest in the group. Also, birth, weaning and yearling weights are adjusted to a mature dam equivalent. Research studies and breeder observations confirm younger (2- and 3-year-old) and older (10-year-old and older) females have lighter calves at weaning than do 5- to 8-year-old cows. To fairly compare calves with dams of different ages, the performance of the calf must be adjusted to what it would be if its dam was at her optimum age for production. These age of dam effects carry over to yearling weight and also influence birth weight, with younger and older females having lighter calves than they would at 5-8 years of age. Examples of age of dam adjustments for weaning weight and birth weight appear in tables 1 and 2.

New adjustment factors reflect not only additional data, but a

Table 1. Weaning weight age of dam adjustment factors for the North American Hereford cattle evaluation

	Old non-creep		New			
Age of dam	bull calf	heifer calf	Percentage	400 lb. calf	550 lb. calf	700 lb. calf
2 yrs.	64.0	54.7	111.48%	45.9	63.1	80.4
4 yrs.	17.6	14.6	101.87%	7.5	10.3	13.1
10 yrs.	11.1	9.0	100.67%	2.7	3.7	4.7
12 yrs.	22.0	18.3	105.87%	23.5	32.3	41.1

Table 2. Birth weight age of dam adjustment factors for the North American Hereford cattle evaluation

	Old non-creep		New			
Age of dam	bull calf	heifer calf	Percentage	65 lb. calf	85 lb. calf	105 lb. calf
2 yrs.	7.20	7.07	109.46%	6.15	8.04	9.93
4 yrs.	1.52	1.54	101.49%	0.97	1.27	1.56
10 yrs.	1.27	1.07	99.75%	-0.16	-0.21	-0.26
12 yrs.	2.30	1.90	103.04%	1.98	2.58	3.19

change in adjustment philosophy. Adjustment factors in the old evaluation were additive, where calf performance was adjusted by a fixed amount given the dam's age, regardless of the calf's performance. The new adjustment factors are multiplicative, meaning that the calf's performance is increased by a percentage of its measurement.

For example, a bull calf born to a 2-year-old (730-day-old) dam would receive a weaning weight adjustment of 64 lb. in the old system, whether its weaning weight was 400 lb. or 700 lb. In the new system, that calf would receive an adjustment of 11.5%. So if the bull calf weighed 550 lb., his adjustment would be 63 lb., nearly identical to the old system. But if he only weighed 400 lb., his performance was less limited by his young dam, and his adjustment would be 11.5% of 400, or 46 lb. Because he only weighed 400 lb., he likely has lower than average growth genetics, and if his dam were at peak production, he would only be expected to weigh 446 lb. (400 lb. weight + 46 adjustment).

If that bull calf from a 2-year-old dam weighed 700 lb., he would receive an adjustment of 80 lb., since a calf with such high growth potential would have been more limited by the young dam. In every case, the adjustment factors predict what the calf would have weighed if his dam were 5 years old, so that all calves can be fairly compared in the genetic evaluation. While the old adjustment equations were different for bull, steer and heifer calves, and for creep-fed versus non-creep-fed calves, the new factors are the same regardless of sex or creep-feeding.

In the old system, bull calves received a greater adjustment than did steers or heifers. In the new system, since weight is adjusted by a percentage, bulls will tend to get greater adjustments since their unadjusted weights are heavier, but no sex factor is needed in the adjustment equation.

Other types of environmental factors are more difficult to quantify, such as differences between regions or even between pastures. These effects are accounted for by contemporary grouping and by considering the heritability of the trait and its genetic correlations with other traits. These genetic parameters were also re-estimated. Heritability describes how much of an animal's performance is due to genetic effects versus environmental effects. Also, heritability determines the range of values for an EPD across the breed and is a key component of the accuracy computation. Heritability estimates used in the old and new analyses are listed in Table 3.

Genetic correlations describe relationships among traits and how they are influenced by some of the same genes. For example, the genetic correlation between weaning and yearling weight in the new analysis is .87. That means that 87% of the genetic effects that influence weaning weight also influence yearling weight, and since the correlation is positive, an animal with genetics for high weaning weight would be expected to have high yearling weight genetics as well. In the multi-trait model used in the NACE, all genetic correlations between traits are used. This increases accuracy of the predictions, especially for unmeasured traits. For example, many producers cull the lightest weaning weight bulls and heifers at weaning, and those animals never have a yearling weight recorded. The multi-trait model accounts for this, using the animals' lighter weaning weights to calculate not only their weaning weight EPDs, but their yearling weight and ultrasound EPDs as well. This prevents culling before yearling from biasing the analysis.

Most parameters were similar to those used in the previous NACE

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Table 3. Heritability estimates used in the North American Hereford cattle evaluation

	Heritability	
Trait	Old	New
Birth weight	0.40	0.43
Weaning weight	0.19	0.20
Yearling weight	0.26	0.31
Scrotal circumference	0.30	0.36
Maternal weaning weight (milk)	0.15	0.10
Ultrasound fat thickness	0.31	0.30
Ultrasound ribeye area	0.23	0.26
Ultrasound intramuscular fat	0.23	0.26
Carcass fat thickness	0.27	0.18
Carcass ribeye area	0.36	0.36
Carcass marbling score	0.49	0.53

Table 4. Significant genetic correlations in the North American Hereford cattle evaluation

	Genetic correlation	
Traits	Old	New
Birth weight and weaning weight	0.40	0.53
Birth weight and yearling weight	0.40	0.54
Weaning weight and yearling weight	0.70	0.87
Weaning weight and scrotal circumference	0.30	0.19
Yearling weight and scrotal circumference	0.40	0.24
Ultrasound fat and ultrasound intramuscular fat	0.30	0.39
Ultrasound fat and carcass fat	0.80	0.87
Ultrasound ribeye and carcass ribeye	0.80	0.93
Ultrasound intramuscular fat and carcass marbling	0.80	0.82
Yearling weight and ultrasound fat	0.10	0.23
Yearling weight and ultrasound ribeye area	0.40	0.55
Yearling weight and ultrasound intramuscular fat	0	-0.09

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and by other beef breed evaluations. Growth traits generally increased in heritability by a small amount, indicating newer data is of higher quality than that submitted decades ago. Heritability of maternal weaning weight (milk EPD) did decline from .15 to .10, likely reflecting the narrowing genetic variation for this trait in the breed, as many of the lowest milk potential animals have been culled out and are not leaving progeny in the next generation. This will also affect accuracy values of milk EPDs, with most animals decreasing in accuracy with the same amount of data, since maternal effects on weaning weight were shown to be more environmental and less genetic than in the previous evaluations.

Some of the more significant genetic correlations in the NACE appear in Table 4 on page 25. Weaning weight and yearling weight continue to be positively correlated with birth weight, resulting in heavier calves at weaning and a year of age, having higher birth weight EPDs if no birth weights are submitted. However, as long as accurate birth weights are submitted, an animal's birth weight and calving ease EPDs will be much more influenced by birth weight and calving ease data than by weaning and yearling weights. Animals that are true "curve-benders," those that have genetics for both superior calving ease and superior growth, will be identified in the database with superior EPDs for both traits, but those animals without birth weight and calving ease observations will not be assumed to be curve-benders just because they have heavier weaning and yearling weights.

In the new data, scrotal circumference is more heritable and less closely related to weaning and yearling weights, so animals with scrotal measurements will have scrotal circumference EPDs that vary more from the breed average, but those without scrotal measurements taken on them or their progeny will have values closer to breed average than before. In recent years, many breeders have included scrotal circumference EPD as a sire selection criterion, creating new generations of animals that are genetically superior for scrotal size and age at puberty, regardless of growth genetics. This is reflected in the scrotal circumference being less a function of growth than in the past.

In summary these new adjustment factors and parameters reflect the increased quality and quantity of data submitted by Hereford breeders in the U.S. and Canada. Using them in the new analysis will only add to the precision of North American Hereford EPDs, helping Hereford breeders more effectively identify and create superior genetics to improve their herds and those of their commercial bull customers.

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