ACROSS-BREED EPD TABLES FOR THE YEAR 2012 ADJUSTED TO BREED DIFFERENCES FOR BIRTH YEAR OF 2010

L. A. Kuehn and R. M. Thallman
Roman L. Hruska U.S. Meat Animal Research Center, USDA-ARS,
Clay Center and Lincoln, NE 68933

Summary

Factors to adjust the expected progeny differences (EPD) of each of 18 breeds to the base of Angus EPD are reported in the column labeled 6 of Tables 1-7 for birth weight, weaning weight, yearling weight, maternal milk, marbling score, ribeye area, and fat thickness, respectively. An EPD is adjusted to the Angus base by adding the corresponding across-breed adjustment factor in column 6 to the EPD. It is critical that this adjustment be applied only to Spring 2012 EPD. Older or newer EPD may be computed on different bases and, therefore, could produce misleading results. When the base of a breed changes from year to year, its adjustment factor (Column 6) changes in the opposite direction and by about the same amount.

Breed differences are changing over time as breeds put emphasis on different traits and their genetic trends differ accordingly. Therefore, it is necessary to qualify the point in time at which breed differences are represented. Column 5 of Tables 1-7 contains estimates of the differences between the averages of calves of each breed born in year 2010. Any differences (relative to their breed means) in the samples of sires representing those breeds at the U.S. Meat Animal Research Center (USMARC) are adjusted out of these breed difference estimates and the across-breed adjustment factors. The breed difference estimates are reported as progeny differences, e.g., they represent the expected difference in progeny performance of calves sired by average bulls (born in 2010) of two different breeds and out of dams of a third, unrelated breed. In other words, they represent half the differences that would be expected between purebreds of the two breeds.

Introduction

This report is the year 2012 update of estimates of sire breed means from data of the Germplasm Evaluation (GPE) project at USMARC adjusted to a year 2010 basis using EPD from the most recent national cattle evaluations. The 2010 basis year is chosen because yearling records for weight and carcass traits should have been accounted for in EPDs for progeny born in 2010 in the Spring 2012 EPD national genetic evaluations. Factors to adjust Spring 2012 EPD of 18 breeds to a common base were calculated and are reported in Tables 1-3 for birth weight (BWT), weaning weight (WWT), and yearling weight (YWT) and in Table 4 for the maternal milk (MILK) component of maternal weaning weight (MWWT). Tables 5-7 summarize the factors for marbling score (MAR), ribeye area (REA), and fat thickness (FAT).

The across-breed table adjustments apply **only** to EPD for most recent (spring, 2012) national cattle evaluations. Serious errors can occur if the table adjustments are used with earlier or later EPD which may have been calculated with a different within-breed base.

The following describes the changes that have occurred since the update released in 2011

(Kuehn et al., 2011):

New samplings of sires in the USMARC GPE program continued to increase progeny records for 16 of the 18 breeds involved in the across-breed EPD program. Approximately 60 progeny per breed were added to the evaluation (birth weight). These additional progeny improve the accuracy of breed differences estimated at USMARC (column 3 in Tables 1-7) particularly for breeds with less data in previous GPE cycles (e.g., Santa Gertrudis, Chiangus). Sires continue to be sampled on a continuous basis, now for each of the 18 breeds in the across-breed EPD program. There are still not enough daughters produced from these new samplings of sires to significantly impact maternal milk estimates. Factors estimated for Santa Gertrudis and Chiangus remain the most susceptile to changes from year-to-year because of increases in progeny number representing greater proportions of their sample. For instance, breed of sire estimates for Santa Gertrudis (yearling weight) and Chiangus (carcass traits) represented some of the largest breed solution estimate changes from last year's analysis.

Other significant changes were largely due to changes in national cattle evaluations for individual breeds. Bases shifts (columns 1 and 2, Tables 1-7) were observed in Braunvieh for most traits. Large mean EPD changes (column 1, Tables 1-7) were also observed in Chiangus and Salers for marbling score, Angus for ribeye area, and Red Angus and Chiangus for fat thickness. Beyond the effects of some of these shifts, most changes were relatively minor relative to Kuehn et al. (2011). In general base shifts only affect the adjustment factors (column 6, Tables 1-7); however, this year changes in Braunvieh also affected their estimated sire breed difference relative to Angus (Column 5, Tables 1-7) because the base shift did not change the mean sire EPDs of USMARC bulls (Column 2, Tables 1-7) to the extent of the mean breed EPD.

Materials and Methods

All calculations were as outlined in the 2010 BIF Guidelines. The basic steps were given by Notter and Cundiff (1991) with refinements by Núñez-Dominguez et al. (1993), Cundiff (1993, 1994), Barkhouse et al. (1994, 1995), Van Vleck and Cundiff (1997–2006), and Kuehn et al. (2007-2011). Estimates of variance components, regression coefficients, and breed effects were obtained using the MTDFREML package (Boldman et al., 1995). All breed solutions are reported as differences from Angus. The table values of adjustment factors to add to within-breed EPD are relative to Angus.

Models for Analysis of USMARC Records

An animal model with breed effects represented as genetic groups was fitted to the GPE data set (Arnold et al., 1992; Westell et al., 1988). In the analysis, all AI sires (sires used via artificial insemination) were assigned a genetic group according to their breed of origin. Due to lack of pedigree, dams mated to the AI sires and natural service bulls mated to F_1 females were also assigned to separate genetic groups (i.e., Hereford dams were assigned to different genetic groups than Hereford AI sires). Cows from Hereford selection lines (Koch et al., 1994) were used in Cycle IV of GPE and assigned into their own genetic groups. Through Cycle VIII, most dams were from Hereford, Angus, or MARCIII (1/4 Angus, 1/4 Hereford, 1/4 Pinzgauer, 1/4 Red Poll) composite lines. In order to be considered in the analysis, sires had to have an EPD for the trait of interest. All AI sires were considered unrelated for the analysis in order to adjust resulting genetic group effects by the average EPD of the sires.

Fixed effects in the models for BWT, WWT (205-d), and YWT (365-d) included breed (fit as genetic groups) and maternal breed (WWT only), year and season of birth by GPE cycle by age of dam (2, 3, 4, 5-9, >10 yr) combination (228), sex (heifer, bull, steer; steers were combined with bulls for BWT), a covariate for heterosis, and a covariate for day of year at birth of calf. Models for WWT also included a fixed covariate for maternal heterosis. Random effects included animal and residual error except for the analysis of WWT which also included a random maternal genetic effect and a random permanent environmental effect.

For the carcass traits (MAR, REA, and FAT), breed (fit as genetic groups), sex (heifer, steer) and slaughter date (229) were included in the model as fixed effects. Fixed covariates included slaughter age and heterosis. Random effects were animal and residual error. To be included, breeds had to report carcass EPD on a carcass basis using age-adjusted endpoints, as suggested in the 2010 BIF Guidelines.

The covariates for heterosis were calculated as the expected breed heterozygosity for each animal based on the percentage of each breed of that animal's parents. In other words, it is the probability that, at any location in the genome, the animal's two alleles originated from two different breeds. Heterosis is assumed to be proportional to breed heterozygosity. For the purpose of heterosis calculation, AI and dam breeds were assumed to be the same breed and Red Angus was assumed the same breed as Angus. For purposes of heterosis calculation, composite breeds were considered according to nominal breed composition. For example, Brangus (3/8 Brahman, 5/8 Angus) × Angus is expected to have 3/8 as much heterosis as Brangus × Hereford.

Variance components were estimated with a derivative-free REML algorithm with genetic group solutions obtained at convergence. Differences between resulting genetic group solutions for AI sire breeds were divided by two to represent the USMARC breed of sire effects in Tables 1-7. Resulting breed differences were adjusted to current breed EPD levels by accounting for the average EPD of the AI sires of progeny/grandprogeny, etc. with records. Average AI sire EPD were calculated as a weighted average AI sire EPD from the most recent within breed genetic evaluation. The weighting factor was the sum of relationship coefficients between an individual sire and all progeny with performance data for the trait of interest relative to all other sires in that breed.

For all traits, regression coefficients of progeny performance on EPD of sire for each trait were calculated using an animal model with EPD sires excluded from the pedigree. Genetic groups were assigned in place of sires in their progeny pedigree records. Each sire EPD was 'dropped' down the pedigree and reduced by ½ depending on the number of generations each calf was removed from an EPD sire. In addition to regression coefficients for the EPDs of AI sires, models included the same fixed effects described previously. Pooled regression coefficients, and regression coefficients by sire breed were obtained. These regression coefficients are monitored as accuracy checks and for possible genetic by environment interactions. The pooled regression coefficients were used as described in the next section to adjust for differences in management at USMARC as compared to seedstock production (e.g., YWT of males at USMARC are primarily on a slaughter steer basis, while in seedstock field data they are primarily on a breeding bull basis). For carcass traits, MAR, REA, and FAT, regressions were considered too variable and too far removed from 1.00. Therefore, the regressions were assumed to be 1.00 until more data is added to reduce the impact of sampling errors on prediction of these regressions. However, the resulting regressions are still summarized.

Records from the USMARC GPE Project are not used in calculation of within-breed EPD by the breed associations. This is critical to maintain the integrity of the regression coefficient. If USMARC records were included in the EPD calculations, the regressions would be biased upward.

Adjustment of USMARC Solutions

The calculations of across-breed adjustment factors rely on breed solutions from analysis of records at USMARC and on averages of within-breed EPD from the breed associations. The basic calculations for all traits are as follows:

USMARC breed of sire solution (1/2 breed solution) for breed i (USMARC (i)) converted to an industry scale (divided by b) and adjusted for genetic trend (as if breed average bulls born in the base year had been used rather than the bulls actually sampled):

M_i = USMARC (i)/b + [EPD(i)$_{YY}$ - EPD(i)$_{USMARC}$].

Breed Table Factor (A_i) to add to the EPD for a bull of breed i:

$A_i = (M_i - M_x) - (\text{EPD(i)}_{YY} - \text{EPD(x)}_{YY})$.

where,

USMARC(i) is solution for effect of sire breed i from analysis of USMARC data,

EPD(i)$_{YY}$ is the average within-breed 2012 EPD for breed i for animals born in the base year (YY, which is two years before the update; e.g., YY = 2010 for the 2012 update),

EPD(i)$_{USMARC}$ is the weighted (by total relationship of descendants with records at USMARC) average of 2012 EPD of bulls of breed i having descendants with records at USMARC,

b is the pooled coefficient of regression of progeny performance at USMARC on EPD of sire (for 2010: 1.18, 0.83, 1.06, and 1.19 BWT, WWT, YWT, and MILK, respectively; 1.00 was applied to MAR, REA, and FAT data),

i denotes sire breed i, and

x denotes the base breed, which is Angus in this report.

Results

Heterosis

Heterosis was included in the statistical model as a covariate for all traits. Maternal heterosis was also fit as a covariate in the analysis of weaning weight. Resulting estimates were 1.30 lb, 13.40 lb, 16.83 lb, 0.021 marbling score units (i.e. 4.00 = Sl^{00}, 5.00 = Sm^{00}), 0.25 in^2, and 0.043 in for BWT, WWT, YWT, MAR, REA, and FAT respectively. These estimates are interpreted as the amount by which the performance of an F_1 is expected to exceed that of its parental breeds. The estimate of maternal heterosis for WWT was 13.14 lb.

Across-breed adjustment factors

Tables 1, 2, and 3 (for BWT, WWT, and YWT) summarize the data from, and results of, USMARC analyses to estimate breed of sire differences on a 2010 birth year basis. The column labeled 6 of each table corresponds to the Across-breed EPD Adjustment Factor for that trait. Table 4 summarizes the analysis of MILK. Tables 5, 6, and 7 summarize data from the carcass analyses (MAR, REA, FAT). Because of the accuracy of sire carcass EPDs and the greatest percentage of data being added to carcass traits, sire effects and adjustment factors are more likely to change for carcass traits in the future.

Column 5 of each table represents the best estimates of sire breed differences for calves born in 2010 on an industry scale. These breed difference estimates are reported as progeny differences, e.g., they represent the expected difference in progeny performance of calves sired by average bulls (born in 2010) of two different breeds and out of dams of a third, unrelated breed. Thus, they represent half the difference expected between purebreds of the respective breeds.

In each table, breed of sire differences were added to the raw mean of Angus-sired progeny born 2006 through 2011 at USMARC (Column 4) to make these differences more interpretable to producers on scales they are accustomed to.

Figures 1-4 illustrate the relative genetic trends of most of the breeds involved (if they submitted trends) adjusted to a constant base using the adjustment factors in column 6 of Tables 1-7. These figures demonstrate the effect of selection over time on breed differences; breeders within each breed apply variable levels of selection toward each trait resulting in reranking of breeds for each traits over time. These figures and Column 5 of Tables 1-7 can be used to identify breeds with potential for complementarity in mating programs.

Across-breed EPD Adjustment Factor Example

Adjustment factors can be applied to compare the genetic potential of sires from different breeds. Suppose the EPD for yearling weight for a Simmental bull is +52.1 (which is below the year 2010 average of 56.3 for Simmental) and for a Gelbvieh bull is +84.0 (which is above the year 2010 average of 74.4 for Gelbvieh). The across-breed adjustment factors in the last column of Table 3 are 22.4 for Simmental and -13.5 for Gelbvieh. Then the adjusted EPD for the Simmental bull is 52.1 + 22.4) = 74.5 and for the Gelbvieh bull is 84.0 + (-13.5) = 70.5. The expected yearling weight difference when both are mated to another breed of cow, e.g., Angus, would be 74.5 – 70.5 = 4.0 lb. The differences in true breeding value between two bulls with similar within-breed EPDs are primarily due to differences in the genetic base from which those within-breed EPDs are computed.

Birth Weight

The range in estimated breed of sire differences for BWT (Table 1, column 5) ranged from 0.5 lb for Red Angus to 7.4 lb for Charolais and 11.0 lb for Brahman. Angus continued to have the lowest estimated sire effect for birth weight (Table 1, column 5). The relatively heavy birth weights of Brahman-sired progeny would be expected to be offset by favorable maternal effects reducing birth weight if progeny were from Brahman or Brahman cross dams which would be an important consideration in crossbreeding programs involving Brahman cross females. Changes in breed of sire effects were generally small, less than 1.5 lb for all breeds relative to last year's update (Kuehn et al., 2011).

Weaning Weight

All of the 17 sire breed differences (Table 2, column 5) were within 5 lb of the values reported by Kuehn et al. (2011). Changes in breed effects caused by new sampling of GPE bulls seem to be stabilizing for both birth weight and weaning weight.

Yearling Weight

Breed of sire effects for yearling weight were also similar to Kuehn et al. (2011) in general. All but three of the estimates were within 6 lb of last year's estimates. The estimated Santa Gertrudis breed difference increased by 9.1 lb and the Maine Anjou difference decreased by 8.1 lb likely due to increased sampling and progeny. The Braunvieh breed of sire difference also decreased by 11.8 lb; however, this change seems to primarily be attributable to changes in the Braunvieh sire evaluation due to the breed mean and the mean EPD of USMARC sampled Braunvieh sires both having changed considerably from last year. Angus continued to have the greatest rate of genetic change for yearling weight, causing all breed of sire differences relative to Angus to decrease at least slightly.

Maternal Milk

Changes to the maternal milk breed of sire differences (Table 4, column 5) were generally small. All changes were less than 6 lb difference from those reported in 2011. However, the breed solution estimates (Table 4, column 3) are expected to change the most in future updates as GPE heifers from each of the 18 breeds being continuously sampled are developed and bred. As this occurs, we expect to be able to produce adjustment factors for maternal milk for Santa Gertrudis and Chiangus.

Marbling

Marbling score was again highest in Angus followed closely by South Devon (0.08 score units lower). Most changes relative to last year's update were minor with the exception of Braunvieh and Salers (genetic evaluation changes) and Chiangus (USMARC breed solution; due to increase numbers of progeny sampled). Continental breeds continue in general to be lower for marbling score relative to Angus (most more than 0.5 score units lower).

Ribeye Area

Continental breeds had higher ribeye area estimates relative to the British breeds (Table 6, column 5) as would be expected. However, differences relative to Angus decrease because of a large change in the mean ribeye area EPD for Angus (0.11 sq in larger). Braunvieh also changed due to genetic evaluation differences relative to last year. Increased sampling of Chiangus steers in GPE has shown them to be quite similar to Angus (only 0.11 sq in larger as a sire breed on average)

Fat Thickness

Progeny of Continental breeds again had 0.1 to 0.2 in less fat at slaughter than British breeds (Table 7, Column 5). All other breeds were leaner than Angus. Charolais, Salers, Maine Anjou, and Simmental were predicted to be the leanest breeds among the 12 breeds analyzed for carcass traits. Limousin was not included in the FAT analysis because they do not report an EPD for FAT. Changes in breed of sire effects relative to Angus were all minor compared to the previous year (Kuehn et al., 2011) except for Braunvieh whose breed mean EPD changed relative to last year's analysis by a significant amount (decreased by almost 0.2 in while the average of the bulls used at USMARC only decrease by approximately 0.1 in).

Accuracies and Variance Components

Table 8 summarizes the average Beef Improvement Federation (BIF) accuracy for bulls with progeny at USMARC weighted appropriately by average relationship to animals with phenotypic records. South Devon bulls had relatively small accuracy for all traits as did Hereford and Brahman bulls. Charolais and Gelbvieh bulls had low accuracy for yearling weight and milk. Accuracies for carcass traits, as expected, were considerably lower than accuracies for growth traits in general. The sires sampled recently in the GPE program have generally been higher accuracy sires, so the average accuracies should continue to increase over the next several years.

Table 9 reports the estimates of variance components from the animal models that were used to obtain breed of sire and breed of MGS solutions. Heritability estimates for BWT, WWT, YWT, and MILK were 0.59, 0.18, 0.46, and 0.16, respectively. Heritability estimates for MAR, REA, and FAT were 0.49, 0.48, and 0.41, respectively.

Regression Coefficients

Table 10 updates the coefficients of regression of records of USMARC progeny on sire EPD for BWT, WWT, and YWT which have theoretical expected values of 1.00. The standard errors of the specific breed regression coefficients are large relative to the regression coefficients. Large differences from the theoretical regressions, however, may indicate problems with genetic evaluations, identification, or sampling. The pooled (overall) regression coefficients of 1.18 for BWT, 0.83 for WWT, and 1.06 for YWT were used to adjust breed of sire solutions to the base year of 2010. These regression coefficients are reasonably close to expected values of 1.0. Deviations from 1.00 are believed to be due to scaling differences between performance of progeny in the USMARC herd and of progeny in herds contributing to the national genetic evaluations of the 18 breeds. Breed differences calculated from the USMARC data are divided by these regression coefficients to put them on an industry scale. A regression greater than one suggests that variation at USMARC is greater than the industry average, while a regression less than one suggests that variation at USMARC is less than the industry average. Reasons for differences in scale can be rationalized. For instance, cattle at USMARC, especially steers and market heifers, are fed at higher energy rations than some seedstock animals in the industry. Also, in several recent years, calves have been weaned earlier than 205 d at USMARC, likely reducing the variation in weaning weight of USMARC calves relative to the industry.

The coefficients of regression for MILK are also shown in Table 10. Several sire (MGS) breeds have regression coefficients considerably different from the theoretical expected value of 1.00 for MILK. Standard errors, however, for the regression coefficients by breed are large except for Angus and Hereford. The pooled regression coefficient of 1.19 for MILK is reasonably close to the expected regression coefficient of 1.00.

Regression coefficients derived from regression of USMARC steer progeny records on sire EPD for MAR, REA, and FAT are shown in Table 11. Each of these coefficients has a theoretical expected value of 1.00. Compared to growth trait regression coefficients, the standard errors even on the pooled estimates are high, though they have decreased from the previous year. While REA and FAT are both close to the theoretical estimate of 1.00, we continued to use the theoretical estimate of 1.00 to derive breed of sire differences and EPD adjustment factors. Pooled regression estimates for these two traits may be used in future updates.

Prediction Error Variance of Across-Breed EPD

Prediction error variances were not included in the report due to a larger number of tables included with the addition of carcass traits. These tables were last reported in Kuehn et al. (2007; available online at http://www.beefimprovement.org/proceedings.html). An updated set of tables is available on request (Larry.Kuehn@ars.usda.gov).

Implications

Bulls of different breeds can be compared on a common EPD scale by adding the appropriate across-breed adjustment factor to EPD produced in the most recent genetic evaluations for each of the 18 breeds. The across-breed EPD are most useful to commercial producers purchasing bulls of two or more breeds to use in systematic crossbreeding programs. Uniformity in across-breed EPD should be emphasized for rotational crossing. Divergence in across-breed EPD for direct weaning weight and yearling weight should be emphasized in selection of bulls for terminal crossing. Divergence favoring lighter birth weight may be helpful in selection of bulls for use on first calf heifers. Accuracy of across-breed EPD depends primarily upon the accuracy of the within-breed EPD of individual bulls being compared.

References

Arnold, J. W., J. K. Bertrand, and L. L. Benyshek. 1992. Animal model for genetic evaluation of multibreed data. J. Anim. Sci. 70:3322-3332.

Barkhouse, K. L., L. D. Van Vleck, and L. V. Cundiff. 1994. Breed comparisons for growth and maternal traits adjusted to a 1992 base. Proc. Beef Improvement Federation 26th Research Symposium and Annual Meeting, Des Moines, IA, May, 1994. pp 197-209.

Barkhouse, K. L., L. D. Van Vleck, and L. V. Cundiff. 1995. Mixed model methods to estimate breed comparisons for growth and maternal traits adjusted to a 1993 base. Proc. Beef Improvement Federation 27th Research Symposium and Annual Meeting, Sheridan, WY. May 31-June 3, 1995. pp 218-239.

Boldman, K. G., L. A. Kriese, L. D. Van Vleck, and S. D. Kachman. 1993. *A Manual for Use of MTDFREML* (DRAFT). A set of programs to obtain estimates of variances and covariances. USDA-ARS, Roman L. Hruska U.S. Meat Animal Research Center, Clay Center, NE. (120 pp).

Cundiff, L. V. 1993. Breed comparisons adjusted to a 1991 basis using current EPD's. Proc. Beef Improvement Federation Research Symposium and Annual Meeting, Asheville, NC. May 26-29, 1993. pp 114-123.

Cundiff, L. V. 1994. Procedures for across breed EPD's. Proc. Fourth Genetic Prediction Workshop, Beef Improvement Federation, Kansas City, MO. Jan. 1994.

Koch, R. M., L. V. Cundiff, and K. E. Gregory. 1994. Cumulative selection and genetic change for weaning or yearling weight or for yearling weight plus muscle score in Hereford cattle. J. Anim. Sci. 72:864-885.

Kuehn, L. A., L. D. Van Vleck, R. M. Thallman, and L. V. Cundiff. 2007. Across-breed EPD tables for the year 2007 adjusted to breed differences for birth year of 2005. Proc. Beef Improvement Federation 39th Annual Research Symposium and Annual Meeting, Fort Collins, CO. June 6-9, 2007. pp 74-92.

Kuehn, L. A., L. D. Van Vleck, R. M. Thallman, and L. V. Cundiff. 2008. Across-breed EPD tables for the year 2008 adjusted to breed differences for birth year of 2006. Proc. Beef Improvement Federation 40th Annual Research Symposium and Annual Meeting, Calgary, AB. June 30-July 3, 2008. pp 53-74.

Kuehn, L. A., L. D. Van Vleck, R. M. Thallman, and L. V. Cundiff. 2009. Across-breed EPD tables for the year 2009 adjusted to breed differences for birth year of 2007. Proc. Beef Improvement Federation 41th Annual Research Symposium and Annual Meeting, Sacramento, CA. April 30-May 3, 2009. pp 160-183.

Kuehn L. A., L. D. Van Vleck, R. M. Thallman, and L. V. Cundiff. 2010. Across-breed EPD tables for the year 2010 adjusted to breed differences for birth year of 2008. Proc. Beef

Improvement Federation 42nd Annual Research Symposium and Annual Meeting, Columbia, MO. June 28-July 1, 2010. pp. 71-92.

Kuehn L. A., L. D. Van Vleck, R. M. Thallman, and L. V. Cundiff. 2011. Across-breed EPD tables for the year 2011 adjusted to breed differences for birth year of 2009. Proc. Beef Improvement Federation 43rd Annual Research Symposium and Annual Meeting, Bozeman, MT. June 1-4, 2011. pp. 92-111.

Notter, D. R., and L. V. Cundiff. 1991. Across-breed expected progeny differences: Use of within-breed expected progeny differences to adjust breed evaluations for sire sampling and genetic trend. J. Anim. Sci. 69:4763-4776.

Núñez-Dominguez, R., L. D. Van Vleck, and L. V. Cundiff. 1993. Breed comparisons for growth traits adjusted for within-breed genetic trend using expected progeny differences. J. Anim. Sci. 71:1419-1428.

Van Vleck, L. D. 1994. Prediction error variances for inter-breed EPD's. Proc. Fourth Genetic Predication Workshop, Beef Improvement Federation, Kansas City, MO. Jan. 1994.

Van Vleck, L. D., and L. V. Cundiff. 1994. Prediction error variances for inter-breed genetic evaluations. J. Anim. Sci. 71:1971-1977.

Van Vleck, L. D., and L. V. Cundiff. 1995. Assignment of risk to across-breed EPDs with tables of variances of estimates of breed differences. Proc. Beef Improvement Federation 27th Research Symposium and Annual Meeting, Sheridan, WY. May 31-June 3, 1995. pp 240-245.

Van Vleck, L. D., and L. V. Cundiff. 1997. Differences in breed of sire differences for weights of male and female calves. Proc. Beef Improvement Federation Research Symposium and Annual Meeting, Dickinson, ND. May 14-17, 1997. pp 131-137.

Van Vleck, L. D., and L. V. Cundiff. 1997. The across-breed EPD tables adjusted to a 1995 base. Proc. Beef Improvement Federation Research Symposium and Annual Meeting, Dickinson, ND. May 14-17, 1997. pp 102-117.

Van Vleck, L. D., and L. V. Cundiff. 1998. Across-breed EPD tables for 1998 adjusted to a 1996 base. Proc. Beef Improvement Federation Research Symposium and Annual Meeting, Calgary, Alberta, Canada. July 2, 1998. pp 196-212.

Van Vleck, L. D., and L. V. Cundiff. 1998. Influence of breed of dam on across-breed adjustment factors. Midwestern Section ASAS and Midwest Branch ADSA 1998 Meeting, Des Moines, IA. Abstract # 10. p 31.

Van Vleck, L. D., and L. V. Cundiff. 1999. Across-breed EPD tables for 1999 adjusted to a 1997 base. Proc. Beef Improvement Federation 31th Annual Research Symposium and Annual Meeting, Roanoke, VA. June 15-19, 1999. pp 155-171.

Van Vleck, L. D., and L. V. Cundiff. 2000. Across-breed EPD tables for 2000 adjusted to a 1998 base. Proc. Beef Improvement Federation 32th Annual Research Symposium and Annual Meeting, Wichita, KS. July 12-15, 2000. pp 98-116.

Van Vleck, L. D., and L. V. Cundiff. 2001. Across-breed EPD tables for 2001 adjusted to breed differences for birth year 1999. Proc. Beef Improvement Federation 33th Annual Research Symposium and Annual Meeting, San Antonio, TX. July 11-14, 2001. pp 44-63.

Van Vleck, L. D., and L. V. Cundiff. 2002. Across-breed EPD tables for 2002 adjusted to breed differences for birth year of 2000. Proc. Beef Improvement Federation 34th Annual Research Symposium and Annual Meeting, Omaha, NE. July 10-13, 2002. pp 139-159.

Van Vleck, L. D., and L. V. Cundiff. 2003. Across-breed EPD tables for the year 2003 adjusted to breed differences for birth year of 2001. Proc. Beef Improvement Federation 35th Annual Research Symposium and Annual Meeting, Lexington, KY. May 28-31, 2003. pp 55-63.

Van Vleck, L. D., and L. V. Cundiff. 2004. Across-breed EPD tables for the year 2004 adjusted to breed differences for birth year of 2002. Proc. Beef Improvement Federation 36th Annual Research Symposium and Annual Meeting, Sioux Falls, SD. May 25-28, 2004. pp 46-61.

Van Vleck, L. D., and L. V. Cundiff. 2005. Across-breed EPD tables for the year 2005 adjusted to breed differences for birth year of 2003. Proc. Beef Improvement Federation 37th Annual Research Symposium and Annual Meeting, Billings, MT. July 6-9, 2005. pp 126-142.

Van Vleck, L. D., and L. V. Cundiff. 2006. Across-breed EPD tables for the year 2006 adjusted to breed differences for birth year of 2004. Proc. Beef Improvement Federation 39th Annual Research Symposium and Annual Meeting, Choctaw, MS. April 18-21, 2006. Available online at: http://www.beefimprovement.org/proceedings/06proceedings/
2006-bif-vanvleck-cundiff.pdf.

Van Vleck, L. D., L. V. Cundiff, T. L. Wheeler, S. D. Shackelford, and M. Koohmaraie. 2007. Across-breed adjustment factors for expected progeny differences for carcass traits. J. Anim. Sci. 85:1369-1376.

Westell, R. A., R. L. Quaas, and L. D. Van Vleck. 1988. Genetic groups in an animal model. J. Dairy Sci. 71:1310-1318.

Table 1. Breed of sire solutions from USMARC, mean breed and USMARC EPD used to adjust for genetic trend to the year 2010 base and factors to adjust within breed EPD to an Angus equivalent – BIRTH WEIGHT (lb)

Breed	Number: AI Sires	Number: Direct Progeny	Ave. Base EPD: Breed 2010 (1)	Ave. Base EPD: USMARC Bulls (2)	Breed Soln at USMARC (vs Ang) (3)	BY 2010 Sire Breed Average (4)	BY 2010 Sire Breed Difference[a] (5)	Factor to adjust EPD To Angus (6)
Angus	128	1735	1.8	1.8	0.0	89.8	0.0	0.0
Hereford	135	2176	3.6	2.3	3.8	94.3	4.5	2.7
Red Angus	42	574	-0.1	-1.2	-0.7	90.3	0.5	2.4
Shorthorn	47	406	2.3	1.4	6.6	96.3	6.5	6.0
South Devon	15	153	2.6	2.0	5.2	94.8	5.0	4.2
Beefmaster	38	343	0.3	1.0	7.0	95.0	5.2	6.7
Brahman	55	653	1.7	0.6	11.7	100.8	11.0	11.1
Brangus	40	336	0.7	1.0	3.5	92.4	2.6	3.7
Santa Gertrudis	21	218	0.6	0.9	7.7	96.0	6.2	7.4
Braunvieh	30	405	2.9	4.3	4.4	92.1	2.2	1.2
Charolais	95	1019	0.6	0.2	8.2	97.2	7.4	8.6
Chiangus	24	218	2.0	2.7	5.0	93.2	3.4	3.3
Gelbvieh	72	939	1.2	1.2	4.1	93.3	3.5	4.0
Limousin	62	1009	1.5	0.7	3.2	93.3	3.5	3.8
Maine Anjou	37	407	1.7	3.9	7.3	93.8	4.0	4.1
Salers	50	405	1.8	2.5	3.0	91.6	1.8	1.8
Simmental	66	969	0.7	1.7	6.0	93.9	4.1	5.2
Tarentaise	7	199	1.9	1.9	2.1	91.6	1.8	1.7

Calculations:

(4) = (3) / b + [(1) – (2)] + (Recent Raw Angus Mean: 89.8 lb) with b = 1.11

(5) = (4) – (4, Angus)

(6) = (5) – (5, Angus) – [(1) – (1, Angus)]

[a]The breed difference estimates represent half the differences that would be expected between purebreds of the two breeds.

Table 2. Breed of sire solutions from USMARC, mean breed and USMARC EPD used to adjust for genetic trend to the year 2010 base and factors to adjust within breed EPD to an Angus equivalent – WEANING WEIGHT (lb)

	Number		Ave. Base EPD		Breed Soln	BY 2010	BY 2010	Factor to
			Breed	USMARC	at USMARC	Sire Breed	Sire Breed	adjust EPD
	AI	Direct	2010	Bulls	(vs Ang)	Average	Difference[a]	To Angus
Breed	Sires	Progeny	(1)	(2)	(3)	(4)	(5)	(6)
Angus	128	1598	47.0	26.3	0.0	582.0	0.0	0.0
Hereford	133	2014	44.0	27.0	-1.7	576.2	-5.8	-2.8
Red Angus	42	556	31.9	26.3	-0.5	566.3	-15.7	-0.6
Shorthorn	45	385	15.0	13.8	2.7	565.7	-16.3	15.7
South Devon	15	134	40.5	23.7	0.5	578.7	-3.3	3.2
Beefmaster	38	334	8.0	13.5	18.7	578.3	-3.7	35.3
Brahman	55	566	14.7	7.5	19.6	592.2	10.2	42.5
Brangus	40	324	23.0	21.8	7.1	571.0	-11.0	13.0
Santa Gertrudis	21	211	5.0	8.3	16.4	577.7	-4.3	37.7
Braunvieh	30	383	40.9	45.1	-0.4	556.7	-25.3	-19.2
Charolais	94	921	24.2	13.4	22.6	599.3	17.3	40.1
Chiangus	24	204	36.8	37.3	-3.2	556.9	-25.1	-14.9
Gelbvieh	71	880	40.0	33.1	10.4	580.8	-1.2	5.7
Limousin	62	928	45.4	29.6	2.0	579.5	-2.5	-0.9
Maine Anjou	37	377	39.4	41.3	1.6	561.4	-20.6	-13.0
Salers	50	383	41.3	32.8	2.8	573.2	-8.8	-3.1
Simmental	65	883	30.8	26.5	20.9	590.7	8.7	24.9
Tarentaise	7	191	16.0	-5.6	1.0	584.1	2.1	33.1

Calculations:

(4) = (3) / b + [(1) – (2)] + (Raw Angus Mean: 561.3 lb) with b = 0.83

(5) = (4) – (4, Angus)

(6) = (5) – (5, Angus) – [(1) – (1, Angus)]

[a]The breed difference estimates represent half the differences that would be expected between purebreds of the two breeds.

Table 3. Breed of sire solutions from USMARC, mean breed and USMARC EPD used to adjust for genetic trend to the year 2010 base and factors to adjust within breed EPD to an Angus equivalent – YEARLING WEIGHT (lb)

Breed	Number: AI Sires	Number: Direct Progeny	Ave. Base EPD: Breed 2010 (1)	Ave. Base EPD: USMARC Bulls (2)	Breed Soln at USMARC (vs Ang) (3)	BY 2010 Sire Breed Average (4)	BY 2010 Sire Breed Difference[a] (5)	Factor to adjust EPD To Angus (6)
Angus	127	1437	85.0	48.3	0.0	1036.8	0.0	0.0
Hereford	128	1836	73.0	44.5	-25.4	1004.6	-32.1	-20.1
Red Angus	37	460	59.6	46.7	-14.4	999.4	-37.4	-12.0
Shorthorn	44	314	24.4	21.0	12.8	1015.6	-21.2	39.4
South Devon	15	134	75.8	50.4	-4.5	1021.3	-15.5	-6.3
Beefmaster	26	170	13.0	22.8	7.4	997.3	-39.5	32.5
Brahman	44	450	23.5	11.6	-33.9	980.0	-56.7	4.8
Brangus	25	168	41.7	40.1	5.5	1006.9	-29.8	13.5
Santa Gertrudis	17	135	7.0	11.1	-3.5	992.7	-44.1	33.9
Braunvieh	23	312	63.5	71.6	-16.2	976.7	-60.0	-38.5
Charolais	92	803	42.6	25.2	25.1	1041.2	4.4	46.8
Chiangus	17	140	68.7	66.9	-13.5	989.1	-47.6	-31.3
Gelbvieh	65	784	74.4	61.1	-0.8	1012.7	-24.1	-13.5
Limousin	55	812	83.0	58.3	-26.2	1000.0	-36.7	-34.7
Maine Anjou	36	294	78.1	84.5	1.8	995.3	-41.4	-34.5
Salers	47	305	79.4	60.9	-1.9	1016.8	-19.9	-14.3
Simmental	63	756	56.3	49.1	24.5	1030.5	-6.3	22.4
Tarentaise	7	189	28.6	-3.6	-32.6	1001.6	-35.2	21.2

Calculations:

(4) = (3) / b + [(1) – (2)] + (Raw Angus Mean: 1000.1 lb) with b = 1.06

(5) = (4) – (4, Angus)

(6) = (5) – (5, Angus) – [(1) – (1, Angus)]

[a]The breed difference estimates represent half the differences that would be expected between purebreds of the two breeds.

Table 4. Breed of maternal grandsire solutions from USMARC, mean breed and USMARC EPD used to adjust for genetic trend to the year 2010 base and factors to adjust within breed EPD to an Angus equivalent – MILK (lb)

Breed	AI Sires	Number Direct Gpr	Direct Progeny	Ave. Base EPD Breed 2010 (1)	Ave. Base EPD USMARC Bulls (2)	Breed Soln at USMARC (vs Ang) (3)	BY 2010 Sire Breed Average (4)	BY 2010 Sire Breed Difference[a] (5)	Factor to adjust EPD To Angus (6)
Angus	123	2788	609	22.0	13.1	0.0	570.2	0.0	0.0
Hereford	120	3530	769	17.0	9.6	-24.1	548.5	-21.7	-16.7
Red Angus	31	519	140	17.4	14.2	-2.4	562.5	-7.7	-3.1
Shorthorn	34	283	88	2.2	4.3	10.8	568.3	-1.9	17.9
South Devon	14	373	70	23.0	19.1	4.4	568.8	-1.3	-2.3
Beefmaster	22	273	54	2.0	-1.6	-8.2	558.0	-12.2	7.8
Brahman	40	791	199	6.3	4.8	16.7	576.9	6.7	22.4
Brangus	21	252	46	10.8	3.4	-3.5	565.8	-4.4	6.8
Braunvieh	16	560	110	34.5	33.8	24.2	582.3	12.2	-0.4
Charolais	79	1268	284	6.8	5.2	-2.6	560.7	-9.5	5.7
Gelbvieh	55	1251	273	16.7	16.8	20.5	578.5	8.3	13.6
Limousin	47	1389	291	20.1	18.0	-5.2	559.1	-11.1	-9.2
Maine Anjou	27	546	104	19.6	23.1	6.3	563.2	-7.0	-4.7
Salers	37	380	107	20.1	21.4	12.8	570.7	0.5	2.4
Simmental	59	1387	287	3.4	5.6	14.6	571.4	1.2	19.8
Tarentaise	6	367	80	0.6	5.3	18.6	572.2	2.0	23.4

Calculations:
(4) = (3) / b + [(1) – (2)] + (Raw Angus Mean: 561.3lb) with b = 1.19
(5) = (4) – (4, Angus)
(6) = (5) – (5, Angus) – [(1) – (1, Angus)]
[a]The breed difference estimates represent half the differences that would be expected between purebreds of the two breeds.

Table 5. Breed of sire solutions from USMARC, mean breed and USMARC EPD used to adjust for genetic trend to the year 2010 base and factors to adjust within breed EPD to an Angus equivalent – MARBLING (marbling score units[a])

Breed	Number: AI Sires	Number: Direct Progeny	Ave. Base EPD: Breed 2010 (1)	Ave. Base EPD: USMARC Bulls (2)	Breed Soln at USMARC (vs Ang) (3)	BY 2010 Sire Breed Average (4)	BY 2010 Sire Breed Difference[b] (5)	Factor to adjust EPD To Angus (6)
Angus	109	646	0.43	0.18	0.00	5.92	0.00	0.00
Hereford	125	860	0.04	-0.01	-0.53	5.19	-0.73	-0.34
Red Angus	36	160	0.07	0.11	-0.04	5.59	-0.34	0.03
Shorthorn	43	183	-0.01	0.01	-0.30	5.34	-0.58	-0.14
South Devon	13	49	0.30	-0.08	-0.21	5.84	-0.08	0.05
Santa Gertrudis	18	75	0.00	-0.01	-0.86	4.82	-1.10	-0.67
Braunvieh	27	164	0.41	0.39	-0.46	5.23	-0.69	-0.67
Charolais	41	189	0.03	-0.04	-0.68	5.05	-0.87	-0.46
Chiangus	19	84	0.25	0.19	-0.41	5.32	-0.60	-0.42
Limousin	54	322	-0.04	-0.08	-0.96	4.75	-1.17	-0.70
Maine Anjou	36	165	0.22	0.14	-0.83	4.92	-1.01	-0.79
Salers	42	151	0.20	-0.37	-0.66	5.58	-0.34	-0.11
Simmental	63	346	0.17	0.10	-0.63	5.11	-0.81	-0.55

Calculations:

(4) = (3) / b + [(1) – (2)] + (Raw Angus Mean: 5.67) with b = 1.00

(5) = (4) – (4, Angus)

(6) = (5) – (5, Angus) – [(1) – (1, Angus)]

[a] 4.00 = Sl^{00}, 5.00 = Sm^{00}

[b] The breed difference estimates represent half the differences that would be expected between purebreds of the two breeds.

Table 6. Breed of sire solutions from USMARC, mean breed and USMARC EPD used to adjust for genetic trend to the year 2010 base and factors to adjust within breed EPD to an Angus equivalent – RIBEYE AREA (in^2)

	Number		Ave. Base EPD		Breed Soln at USMARC	BY 2010 Sire Breed	BY 2010 Sire Breed	Factor to adjust EPD
Breed	AI Sires	Direct Progeny	Breed 2010 (1)	USMARC Bulls (2)	(vs Ang) (3)	Average (4)	Difference[a] (5)	To Angus (6)
Angus	109	647	0.32	0.05	0.00	12.96	0.00	0.00
Hereford	125	860	0.25	-0.04	-0.21	12.77	-0.18	-0.11
Red Angus	36	160	0.07	-0.17	-0.32	12.60	-0.35	-0.10
Shorthorn	43	183	0.05	0.01	0.13	12.86	-0.10	0.17
South Devon	13	49	0.21	0.21	0.31	12.99	0.04	0.15
Santa Gertrudis	18	76	0.02	0.01	-0.23	12.46	-0.49	-0.19
Braunvieh	27	164	0.73	0.79	0.96	13.59	0.64	0.23
Charolais	41	190	0.20	0.08	0.95	13.76	0.81	0.92
Chiangus	19	85	0.03	0.10	0.45	13.06	0.11	0.40
Limousin	54	323	0.53	0.29	1.30	14.24	1.28	1.07
Maine Anjou	36	165	0.16	0.17	1.00	13.67	0.72	0.88
Salers	42	152	0.02	0.03	0.73	13.40	0.45	0.75
Simmental	63	347	0.19	0.02	0.89	13.75	0.79	0.92

Calculations:

(4) = (3) / b + [(1) – (2)] + (Raw Angus Mean: 12.69 in^2) with b = 1.00

(5) = (4) – (4, Angus)

(6) = (5) – (5, Angus) – [(1) – (1, Angus)]

[a]The breed difference estimates represent half the differences that would be expected between purebreds of the two breeds.

Table 7. Breed of sire solutions from USMARC, mean breed and USMARC EPD used to adjust for genetic trend to the year 2010 base and factors to adjust within breed EPD to an Angus equivalent – FAT THICKNESS (in)

Breed	Number: AI Sires	Number: Direct Progeny	Ave. Base EPD: Breed 2010 (1)	Ave. Base EPD: USMARC Bulls (2)	Breed Soln at USMARC (vs Ang) (3)	BY 2010 Sire Breed Average (4)	BY 2010 Sire Breed Difference[a] (5)	Factor to adjust EPD To Angus (6)
Angus	109	647	0.009	0.000	0.000	0.587	0.000	0.000
Hereford	125	860	0.001	-0.003	-0.056	0.526	-0.061	-0.053
Red Angus	36	160	0.000	-0.008	-0.042	0.544	-0.043	-0.034
Shorthorn	43	183	-0.012	-0.004	-0.152	0.418	-0.169	-0.148
South Devon	13	49	0.010	0.008	-0.103	0.477	-0.110	-0.111
Santa Gertrudis	18	76	0.000	0.004	-0.110	0.463	-0.124	-0.115
Braunvieh	27	164	-0.092	-0.106	-0.200	0.391	-0.196	-0.095
Charolais	41	190	0.000	0.000	-0.222	0.356	-0.231	-0.222
Chiangus	19	85	0.024	0.016	-0.141	0.445	-0.142	-0.157
Maine Anjou	36	165	0.003	-0.023	-0.233	0.371	-0.216	-0.210
Salers	42	152	0.000	-0.005	-0.216	0.368	-0.219	-0.210
Simmental	63	347	0.012	0.013	-0.203	0.375	-0.212	-0.215

Calculations:

(4) = (3) / b + [(1) – (2)] + (Raw Angus Mean: 0.578 in) with b = 1.00

(5) = (4) – (4, Angus)

(6) = (5) – (5, Angus) – [(1) – (1, Angus)]

[a]The breed difference estimates represent half the differences that would be expected between purebreds of the two breeds.

Table 8. Mean weighted[a] accuracies for birth weight (BWT), weaning weight (WWT), yearling weight (YWT), maternal weaning weight (MWWT), milk (MILK), marbling (MAR), ribeye area (REA), and fat thickness (FAT) for bulls used at USMARC

Breed	BWT	WWT	YWT	MILK	MAR	REA	FAT
Angus	0.79	0.76	0.70	0.71	0.51	0.50	0.48
Hereford	0.65	0.61	0.60	0.57	0.24	0.38	0.28
Red Angus	0.92	0.91	0.91	0.88	0.80	0.80	0.80
Shorthorn	0.81	0.80	0.73	0.78	0.61	0.60	0.54
South Devon	0.37	0.41	0.37	0.44	0.02	0.05	0.05
Beefmaster	0.86	0.89	0.87	0.75			
Brahman	0.66	0.67	0.59	0.60			
Brangus	0.87	0.81	0.79	0.68			
Santa Gertrudis	0.85	0.82	0.78		0.31	0.52	0.44
Braunvieh	0.54	0.47	0.36	0.40	0.10	0.13	0.08
Charolais	0.79	0.73	0.64	0.67	0.48	0.50	0.45
Chiangus	0.82	0.79	0.79		0.52	0.51	0.55
Gelbvieh	0.82	0.77	0.63	0.66			
Limousin	0.93	0.90	0.84	0.84	0.74	0.74	
Maine Anjou	0.78	0.77	0.75	0.75	0.35	0.35	0.35
Salers	0.83	0.82	0.77	0.81	0.23	0.27	0.31
Simmental	0.94	0.94	0.94	0.92	0.81	0.80	0.81
Tarentaise	0.96	0.95	0.95	0.94			

[a]Weighted by relationship to phenotyped animals at USMARC for BWT, WWT, YWT, MAR, REA, and FAT and by relationship to daughters with phenotyped progeny MILK.

Table 9. Estimates of variance components (lb^2) for birth weight (BWT), weaning weight (WWT), yearling weight (YWT), and maternal weaning weight (MWWT) and for marbling (MAR; marbling score units^2), ribeye area (REA; in^4), and fat thickness (FAT; in^2) from mixed model analyses

	Direct		
Analysis	BWT	WWT[a]	YWT
Direct			
Animal within breed (19 breeds)	72.31	489.62	3669.03
Maternal genetic within breed (17 breeds)		433.09	
Maternal permanent environment		724.34	
Residual	50.53	1213.12	4324.94
Carcass Direct	MAR	REA	FAT
Animal within breed (12-13 breeds)	0.279	0.660	0.0100
Residual	0.294	0.728	0.0144

[a]Direct maternal covariance for weaning weight was -83.33 lb^2

Table 10. Pooled and within-breed regression coefficients (lb/lb) for weights at birth (BWT), 205 days (WWT), and 365 days (YWT) of F_1 progeny and for calf weights (205 d) of F_1 dams (MILK) on sire expected progeny difference and by sire breed

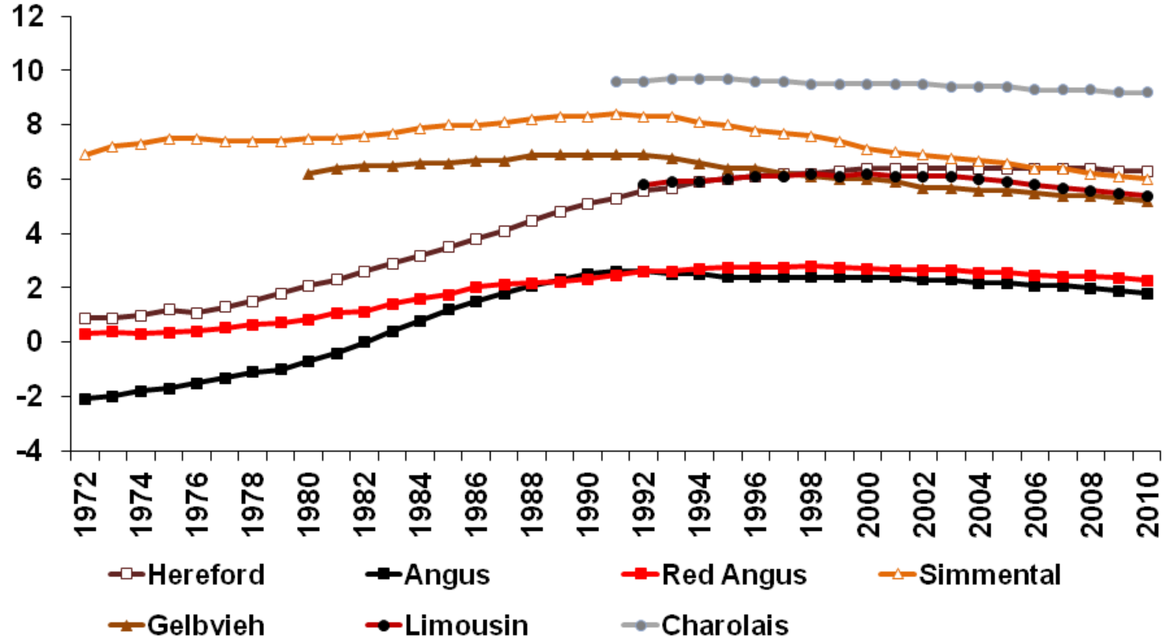
	BWT	WWT	YWT	MILK
Pooled	1.18 ± 0.04	0.83 ± 0.04	1.06 ± 0.05	1.19 ± 0.08
Sire breed				
Angus	1.05 ± 0.10	0.83 ± 0.08	1.26 ± 0.08	1.14 ± 0.16
Hereford	1.19 ± 0.07	0.76 ± 0.05	1.03 ± 0.06	1.08 ± 0.16
Red Angus	1.25 ± 0.16	0.72 ± 0.16	0.56 ± 0.20	1.59 ± 0.34
Shorthorn	0.48 ± 0.24	0.79 ± 0.24	0.69 ± 0.29	0.95 ± 0.93
South Devon	-0.22 ± 0.63	0.02 ± 0.56	-0.01 ± 0.48	-0.22 ± 1.54
Beefmaster	2.07 ± 0.37	1.19 ± 0.31	1.02 ± 0.50	3.94 ± 0.72
Brahman	2.11 ± 0.22	1.02 ± 0.21	1.23 ± 0.24	0.34 ± 0.51
Brangus	1.54 ± 0.28	0.45 ± 0.31	0.80 ± 0.42	0.45 ± 0.77
Santa Gertrudis	4.51 ± 0.87	1.44 ± 0.39	0.45 ± 0.42	
Braunvieh	0.80 ± 0.28	1.39 ± 0.31	0.95 ± 0.45	2.99 ± 1.06
Charolais	1.14 ± 0.13	0.95 ± 0.12	0.82 ± 0.13	1.16 ± 0.30
Chiangus	1.88 ± 0.35	0.73 ± 0.35	0.79 ± 0.46	
Gelbvieh	1.04 ± 0.14	0.96 ± 0.17	1.19 ± 0.18	1.32 ± 0.46
Limousin	0.94 ± 0.12	0.98 ± 0.10	1.17 ± 0.13	1.45 ± 0.29
Maine Anjou	1.47 ± 0.20	0.56 ± 0.27	0.71 ± 0.32	1.07 ± 0.52
Salers	1.28 ± 0.25	0.91 ± 0.34	0.51 ± 0.31	1.75 ± 0.51
Simmental	1.21 ± 0.17	1.52 ± 0.15	1.43 ± 0.15	0.75 ± 0.39
Tarentaise	1.50 ± 1.37	0.70 ± 0.61	1.49 ± 0.84	1.00 ± 0.93

Table 11. Pooled and within-breed regression coefficients marbling (MAR; score/score), ribeye area (REA; in^2/in^2), and fat thickness (FAT; in/in) of F_1 progeny on sire expected progeny difference and by sire breed

	MAR	REA	FAT
Pooled	0.60 + 0.05	0.91 + 0.07	1.18 + 0.10
Sire breed			
Angus	1.00 + 0.10	1.03 + 0.17	1.40 + 0.17
Hereford	0.54 + 0.18	0.60 + 0.15	1.02 + 0.21
Red Angus	0.59 + 0.19	1.15 + 0.27	0.64 + 0.50
Shorthorn	1.75 + 0.34	1.25 + 0.62	2.22 + 0.55
South Devon	-0.61 + 0.67	1.64 + 3.21	5.60 + 4.58
Santa Gertrudis	-0.18 + 1.12	1.07 + 0.54	1.44 + 0.68
Braunvieh	0.80 + 0.55	0.12 + 0.28	0.35 + 0.44
Charolais	1.07 + 0.29	1.44 + 0.32	1.60 + 0.53
Chiangus	0.70 + 0.25	0.61 + 0.51	0.05 + 0.60
Limousin	1.25 + 0.41	1.34 + 0.19	
Maine Anjou	0.10 + 0.40	-1.03 + 0.63	1.03 + 0.74
Salers	0.05 + 0.09	2.38 + 0.77	1.03 ± 0.93
Simmental	0.78 + 0.21	0.73 + 0.18	1.83 ± 0.45

Figure 1. Relative genetic trends for birth weight (lb) of the seven most highly used beef breeds (1a) and all breeds that submitted 2012 trends (1b) adjusted for birth year 2010 using the 2012 across-breed EPD adjustment factors.

1a.



1b.

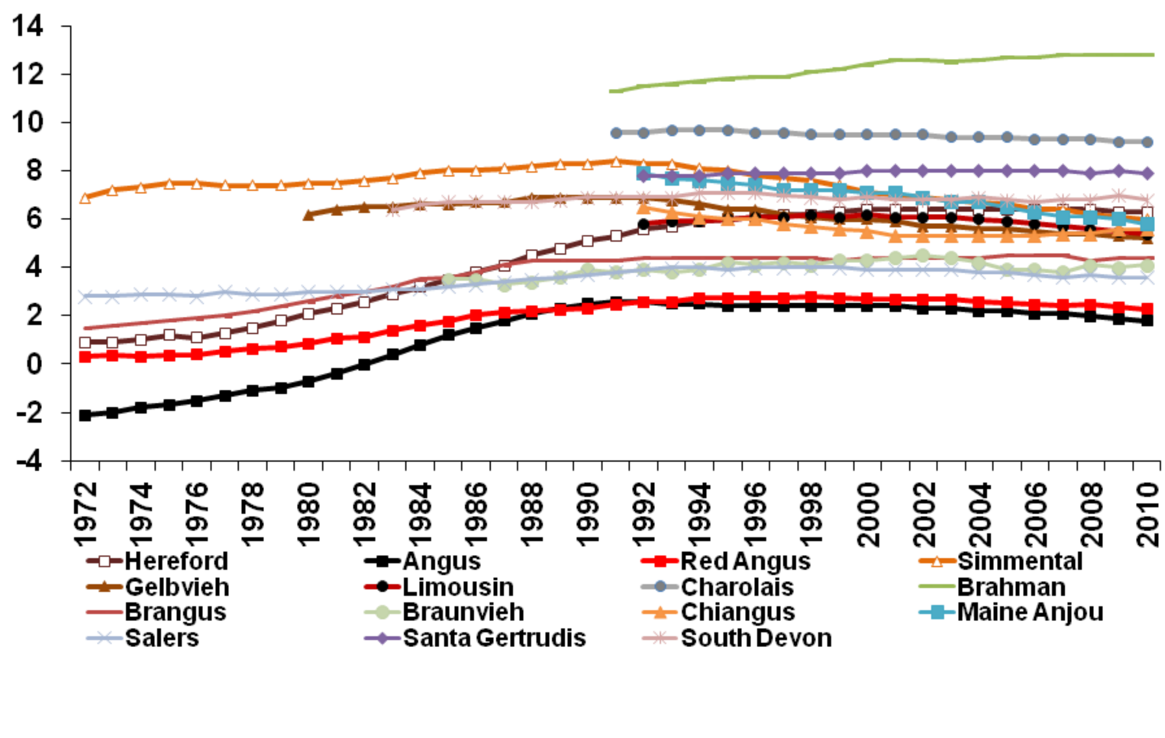
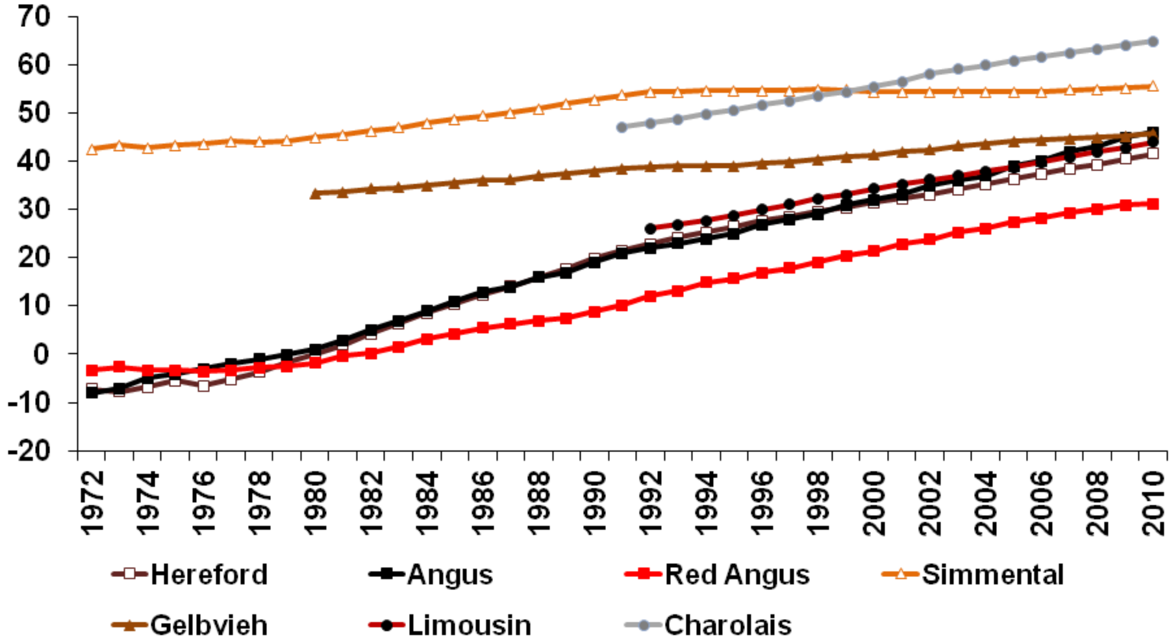


Figure 2. Relative genetic trends for weaning weight (lb) of the seven most highly used beef breeds (2a) and all breeds that submitted 2012 trends (2b) adjusted for birth year 2010 using the 2012 across-breed EPD adjustment factors.

2a.



2b.

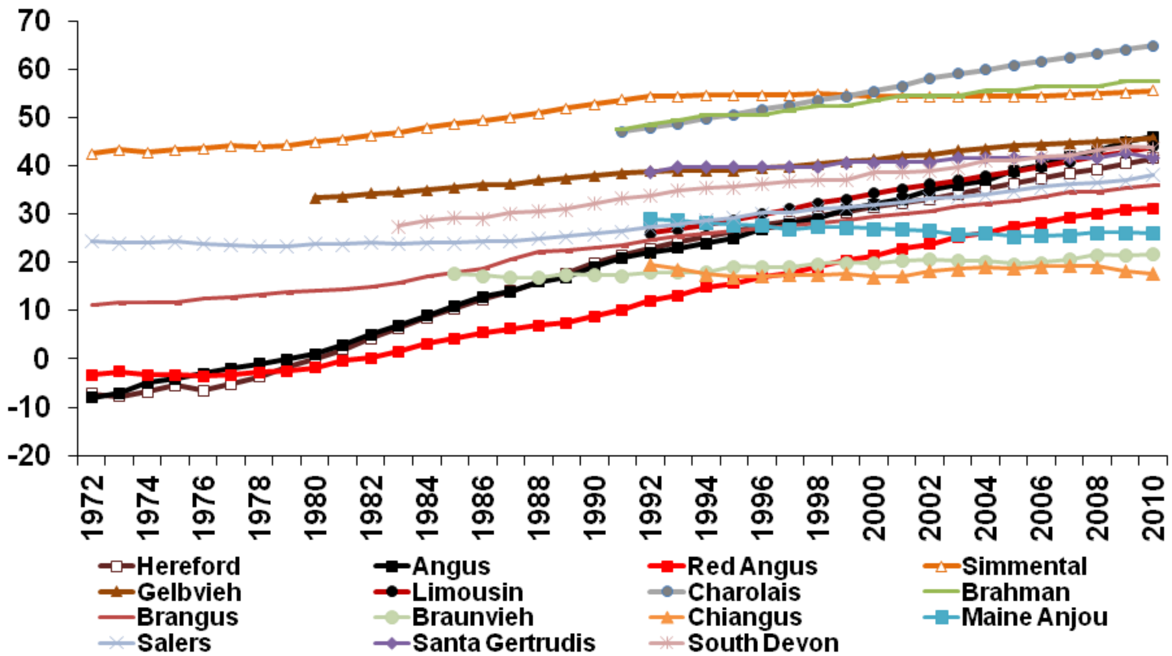
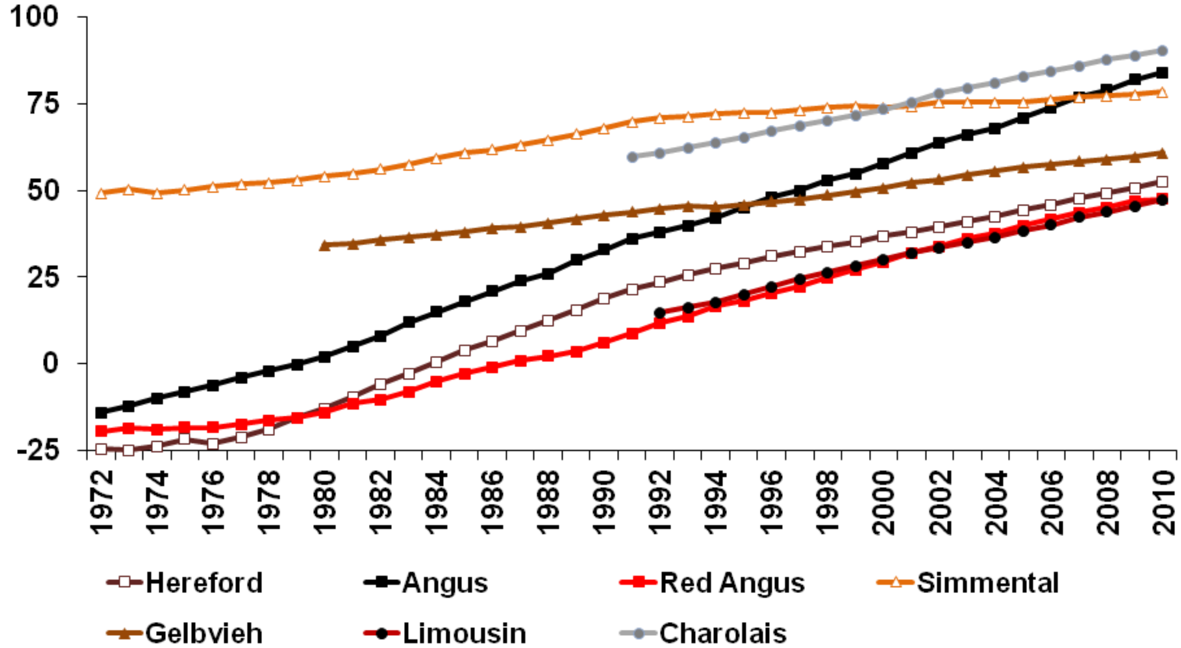


Figure 3. Relative genetic trends for yearling weight (lb) of the seven most highly used beef breeds (3a) and all breeds that submitted 2012 trends (3b) adjusted for birth year 2010 using the 2012 across-breed EPD adjustment factors.

3a.



3b.

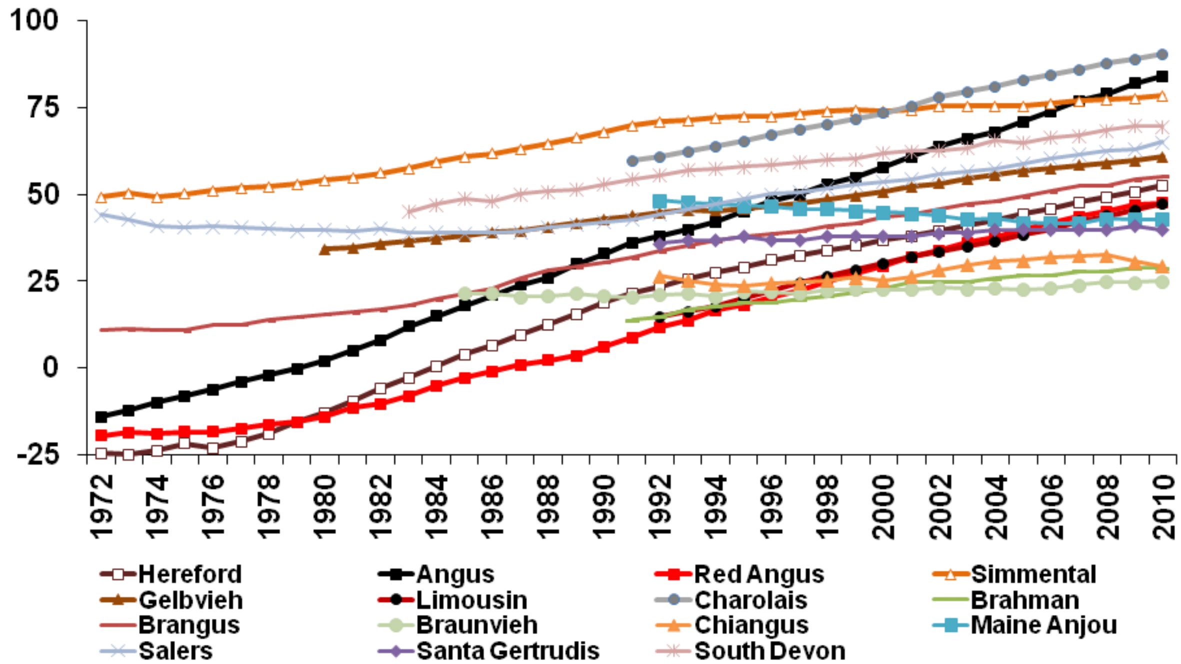
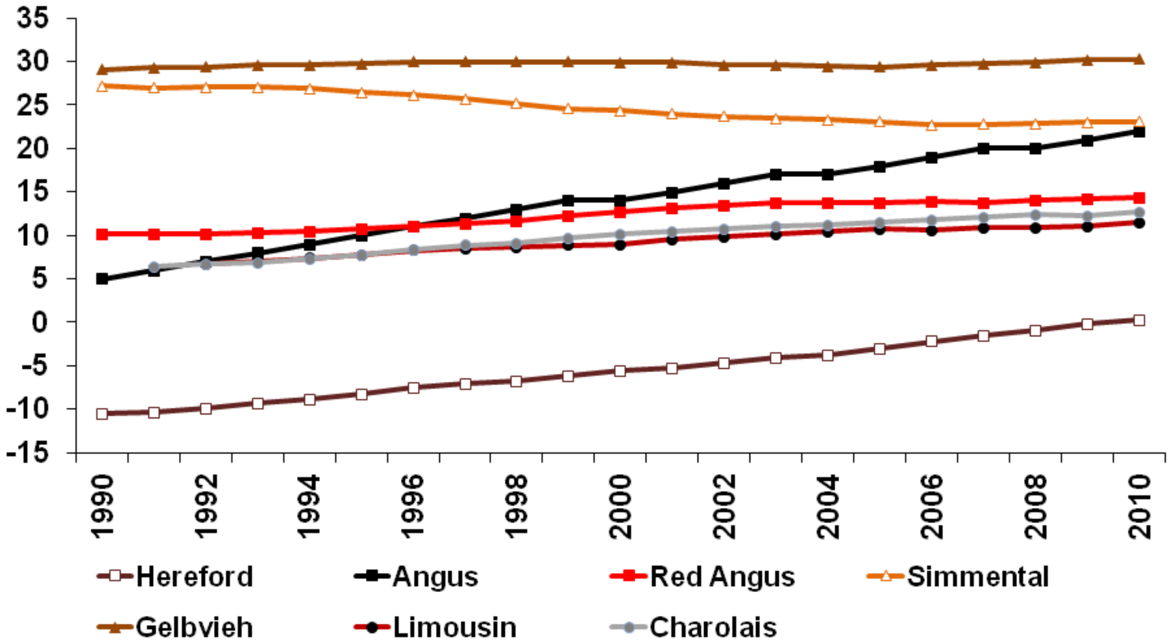


Figure 4. Relative genetic trends for maternal milk (lb) of the seven most highly used beef breeds (4a) and all breeds that submitted 2012 trends (4b) adjusted for birth year 2010 using the 2012 across-breed EPD adjustment factors.

4a.



4b.