Economic and Environmental Repercussions of Changing Bull Genetics

By Daniel Keeton, Michael Popp, and S. Aaron Smith

ABSTRACT

This research models net return and greenhouse gas emissions (GHG) implications of bull genetics on cow-calf operations using conditions reflective of Arkansas farms. Operation-specific details for a representative farm are described and impacts of bull selection on net returns for the entire operation as well as on a per cow basis are calculated. Further, the analysis highlights situations where bull selection could be both profitable and used to mitigate GHG emissions. Results suggest that profitability changes as a result of bull selection were larger than the associated change in GHG emissions. Modeled results indicated that genetic selections that increase birthing difficulty are economically detrimental and increase GHG emissions per pound of beef sold. Finally, changes in breed driven hide color price premiums are relatively consistent over time.

Introduction

Cow-calf operators have many breeds and cross-breeds to choose from when choosing bulls for their operation. Normally, when operators are choosing bulls, factors such as birth weight, weaning weight, and calf hide color are considered when making decisions related to genetics (Greiner, 2005). For Arkansas cow-calf operators, bulls with black hide (Angus, Brangus, etc.) seem to be most popular as nearly 53 percent of calves sold at Arkansas cattle auctions in 2010 possessed a black hide (Troxel & Barham, 2012).



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With concerns over climate change, farmers may also be interested in tracking greenhouse gas (GHG) emissions from their farm, a metric that some retailers are using to showcase their sustainability efforts or differentiate their product. Thus, some operators are looking at practices that minimize GHG emissions such as reducing the use of fuel and commercial fertilizer. Nonetheless, for many cow-calf farms, cattle are the largest source of GHG emissions when considering carbon dioxide (CO_2) released via gases leaving the body, methane (CH_4) released through enteric fermentation, and the release of nitrous oxide (N_2O) from the breakdown of manure and urine. The selection of the bull, to modify breed driven herd performance, is thus an important variable as calving ease and weaning weight affect the amount of beef produced per cow and hence profitability as well as GHG emissions. The analysis of breed selection, however, is also operation-specific as modifications to grazing strategy, forage species selection, fertilizer application, calving season, and feed supplementation would also affect economic and GHG emission performance.

Therefore, the economic impact of modifying genetics is not easily calculated and hence operators have a hard time determining what to pay for a new bull. A spreadsheet-based decision aid that can assist with the analysis of higher calf performance statistics versus higher genetics costs is thus desirable and recently available in the Forage and Cattle Planner (FORCAP v1), available at http:// agribus.uark.edu /2910.php. Higher weaning weights modify feed requirements and different hide colors lead to varying premiums or discounts in the market place. Calf weaning rate may decline with greater calving difficulties leading to potential losses and greater veterinary expense. Also, if all of a farm's cows are polled and the current bull is polled, then a switch to a horned bull could produce a large amount of horned calves. This would require either dehorning the calves at increased expense or accepting price discounts associated with horned calves.

The objective of this analysis was thus to demonstrate how FORCAP can be used to analyze a bull purchasing decision. Specifically we examine profitability and GHG emissions implications of changing bulls across six commercial cow breed alternatives. Further, the analysis highlights drivers of profitability and GHG emissions changes and demonstrates how consistent bull selection is over time and across cow breed. We also analyze whether GHG mitigation can be profitable.

Materials and Methods

Across-Breed EPD Table

An Across-Breed EPD table was used to calculate the genetic impact of bull selection on birth and weaning weights. Table 1 shows the Across-Breed EPD values from the updated 2012 version of the U.S. Meat Animal Research Center (MARC) (Kuehn and Thallman 2012a). For within breed comparisons, EPD values are commonly used to track the quality of a bull compared to his breed average; however, with an Across-Breed EPD table, comparisons can be made between two bulls of different breeds. Across-breed EPD values are the adjustments needed to equalize breed EPD values across all breeds using a base breed of Angus in this case. Further, having Across-Breed EPD values, comparisons can be made between two bulls of different breeds with or without known breed EPD values. The table used provided Across-Breed EPD values for birth, weaning, and yearling weights, milk, marbling, ribeye area, and fat thickness. Where available, these values are shown for 18 beef cattle breeds. In FORCAP, birth, weaning, and yearling weight EPD values, labeled BW, WW, and YW, respectively, are shown in Figure 1, but only EPD values related to birth and weaning weight are actually used in the model when changing bull genetics as price information used in the calculator is limited to #3-700 calves and hence yearling weights, while of interest, are heavier than the range of price information available. Further, these traits are thought to be most important in calf performance for an operation typically selling their calves at weaning (Hammack, 2008).

Operators that know the EPD values of their existing bull, the new bull, or both, can enter these numbers instead of accepting the default breed averages as reported in Table 1 (Kuehn & Thallman, 2012c). To calculate expected birth weight differences as a result of bull selection, the new bull's breed average EPD value for one trait is adjusted with that traits' Across-Breed EPD value, and then subtracted from the existing bull's EPD value that is also adjusted for Across-Breed EPD value. For example, if comparing birth weight between an existing Angus bull and a new Simmental bull, take the Simmental's 0.7 breed average BW EPD value and adjust it by adding the Simmental Across-Breed BW EPD value of 5.2 for an adjusted Simmental 5.9 BW EPD value. For the Angus bull, the adjusted Angus BW EPD value is its breed average 1.8 BW EPD value plus the Angus Across-Breed EPD BW value of 0. Subtracting the Angus BW of 1.8 from the Simmental BW of 5.9 implies that, on average, when bred to the same cows, the Simmental bull is expected to sire calves with birth weights that are 4.1 pounds heavier than Angus sired calves (in Figure 1 we show a 1.8 lb. heavier birth weight for Tarentaise compared to Angus sired calves with Commercial White Cows). The process described is repeatable with other traits and user specified EPD values rather than breed average EPD values in FORCAP. We used breed averages for birth and weaning weight in this analysis to limit the number of potential comparisons.

Price Adjustment Factors

Breed specific price-to-state average price ratios were calculated using prices from 14 Arkansas livestock auctions to generate average prices for seven breeds, thirteen crossbreeds, and ten hide colors in 2000 (Troxel et al., 2002), 2005 (Barham & Troxel, 2007), and 2010 (Troxel & Barham, 2012). These price ratios, as shown in Table 2, were the reported, average annual hundredweight (CWT) price for a particular breed, crossbreed, or hide color divided by the reported overall average annual CWT price (Troxel & Barham, 2012) of all weekly prices received for calves and yearlings over the course of the reported year and across the 14 different auctions. Since the reported prices were annual averages, possible effects of changes in price premiums or discounts by selling month, sale barn or weight class are not accounted for. Reported overall average prices for 2010, 2005, and 2000 were $108.58, $118.10, and $93.95, respectively. In the model, this price ratio by breed was used to adjust for hide color and other breed differences by multiplying it with the state average price for a particular weight class, gender and selling month as reported by the Agricultural Marketing Service in Little Rock, AR (Cheney, 2011).

Further, FORCAP allows users to choose several cattle price levels: 2012, 5-year, and 10-year average monthly Arkansas calf, cow, and cull bull prices. Since year-round calving was assumed as the primary choice of calving season for Arkansas cow-calf operations, Table 3 reports the 2012, 5-year, and 10-year average prices by cattle class as used in this analysis. Along with these average cattle prices, the price ratios reported in Table 2 were used to adjust price expectations for the 18 different breeds analyzed in this paper. In FORCAP, should a user choose 2012 cattle prices, the 2010 breed to state average price ratios for the different breeds were applied. Should the user select the 5-year or 10-year average cattle price options in FORCAP, price ratios from 2005 and 2010 or an average of the 2000, 2005, and 2010 price ratios are implemented, respectively. This allowed repeating the bull selection analysis using different price levels and associated breed price factors to see if profitability of bull selection changed over time.

To determine which price factor most accurately represents the user's operation the user can specify a breed or composite breed for the majority of their cows in FORCAP as shown in Figure 1 (A). The user may choose from the 18 bull breeds along with 18 purebred cow breeds and six commercial cow breed options to find the best match for their cow herd. The six commercial options are based upon the four major hide colors (black, red, yellow, and white), a spotted or striped hide, and an overall commercial herd that does not show a particular dominant hide color. Price factors for the overall commercial option are the averages of the five other commercial options. Price factors for the spotted commercial option will not change due to bull selection because calves are assumed to still show spots or stripes. Price factors for the overall commercial option will not change due to bull selection because there will still be a large amount of hide color variance. Hence, using the commercial and spotted commercial cow breed options, analyzes bull selection only from a birth and weaning weight perspective whereas selection of commercial red, white, black, and yellow options reveal both weight and price factor impacts across breeds.

Breed Adjustments

Based on the user's answers for both the cow breed (A) and the breed of bull (B) in Figure 1, price factors, adjusted birth and weaning weights, as well as anticipated changes in calving difficulty were applied to relevant parameters throughout FORCAP. Calving difficulty increased by two percent for each added pound of birth weight (Ritchie & Anderson, 1994). Cow and calf losses from dystocia as well as the number of anticipated caesarian sections increase as calving difficulty increases using parameter values reported in McDermott et al. (1991). Even after the calf is born, there may be lingering side effects from a difficult birth (Cooke, Villarroel, and Estill 2008). The model accounts for these breed effects by providing an anticipated change in calving difficulty (C) in Figure 1 to modify calving assistance costs. It also multiplies this increase in calving difficulty by 0.135 and 0.05 (McDermott et al., 1991) to change calf and cow death loss percentages, respectively. To properly capture calving problems, both bull and cow effects were considered. To capture the cow's effect, the birth weight value for cows was set at the same level as for that of the bull of the same breed. Therefore, an anticipated increase in calving difficulty would only be expected if the new bull's birth weight was higher than both the existing bull's birth weight and the existing cow's birth weight.

Greenhouse Gas Emissions

The three most quantified GHG gases emitted by cattle operations are CO_2, CH_4, and N_2O. In FORCAP, cattle CO_2 emissions were estimated using the approach espoused by Kirchgessner et al. (1991). Methane and N_2O emissions were estimated using IPCC tier II estimates for livestock emissions (IPCC, 2007). All cattle emissions from enteric fermentation, manure and urine, were converted to CO_2 equivalents to account for differences in global warming potential (GWP). Methane and N_2O have a GWP of 25 and 298 times that of CO_2, respectively. Greenhouse gas emissions from the decomposing of dead animals was not included in GHG calculations and neither were GHG emissions associated with supplemental feed purchased as both sources are expected to be minor when making comparisons across bulls as only the change in death loss or supplemental feed would play a role. Emissions are reported as GHG emissions per live weight sold in Figure 1 (F). For this measurement, net cattle emissions by the herd and from operation of machinery and fertilizer application are divided by the total weight of all cattle sold from the farm including calves, cull cows, and cull bulls. Depending on replacement rate, as affected by death losses from bull selection, some cow-calf operations sell more calves, on an annual basis, than cull cows and bulls combined. In these instances calf weights can have a relatively large impact on GHG emissions. The interested reader is directed to Smith, Popp, and Keeton (2013) for further details on GHG emission calculations in FORCAP.

Baseline

To demonstrate the economic and GHG effects associated with the purchase of a new bull, a baseline farm was required to make comparisons using FORCAP. This baseline was developed to reflect production choices of a typical Arkansas cow-calf operation. Given the large variation in operation types observed in Arkansas, a typical or statistically representative average farm is a difficult concept. The following parameters were used as a representative operation or baseline farm in FORCAP:

- Commodity and input prices were for 2012 (reported in Table 3);
- A medium-sized farm with 60 hay acres and 180 pasture acres;
- Fertilizer application on hay land of 0.25 tons/acre of lime, 100 lbs./acre of ammonium nitrate (34-0-0), and 2 tons/acre of poultry litter (3-2-3);
- Fertilizer application on pasture land of 0.25 tons/acre of lime and 0.5 ton/acre of poultry litter;
- Forage species composition by area for the pasture was 25 percent bermudagrass, 65 percent fescue, and 10 percent clover;

- Hay land forage species composition by area was 50 percent bermudagrass, 45 percent fescue, and 5 percent clover;
- Continuous grazing on pasture was assumed resulting in an expected grazing efficiency of 50 percent such that half of forage growth two inches in height above the ground would be eaten by cattle with the remainder going unused due to bedding, trampling, presence of manure paddies, or not grazed due to palatability issues of mature forage;
- No winter annuals were sod seeded and the farm did not bale excess hay from pastures or use stock piling;
- Cattle management practices assumed year-round calving with a resultant year-round calf sale distribution at a weaning age of seven months;
- Both birth and weaning weight were adjusted by typical breed performance estimates (Table 4);
- Bagged corn was fed as the supplemental feed when total digestible nutrients (TDN) needs for the herd were not met on a month to month basis;
- Equipment and building ownership charges were not considered in the analysis as bull selection would not affect them;
- All other cattle management practices used are shown in Table 5.

Note that these production parameters can be changed in FORCAP and would change the profitability and GHG emissions results reported in this paper. The interested reader can download FORCAP as well as the user and reference manual to adjust operational characteristics to fit their operation-specific details.

Baseline Genetics and Prices

Baseline genetics were established by the FORCAP user's answer to cow herd composition and bull breeds using breed average EPD values (Table 1) along with birth and weaning weight information for the base cow breed reported in Table 4. The baseline genetics used in this paper consisted of a Commercial White cow herd and average Angus bulls using 2012 cattle prices along with the 2010 price adjustment factors.

To determine whether the choice of baseline genetics had an impact on the profit- maximizing bull breed chosen, sensitivity analysis was performed by changing the baseline breed from Angus x Commercial White to each of the five other commercial cow breed choices as purebred cow herds were not considered in this analysis. The interested reader can contact the authors for the complete comparison across all breed choices. To analyze for consistency of bull selection over time, the Angus x Commercial White baseline was also evaluated using the 5-year and 10-year average price levels and associated breed price factors.

Breakeven Purchase Price

To calculate a breakeven new bull purchase price, FORCAP users can modify the cell described as the 'Cost of the New Bull(s)' near the middle right in Figure 1 (D) and monitor profitability changes with the introduction of new bull genetics at the same time. For example, selecting a bull with higher weaning weight would lead to greater feed intake and GHG emissions. A higher birth weight, as discussed above leads to potentially greater calving difficulty which could affect the number of calves sold as well as veterinary charges and cow death losses (the model rounds to the nearest animal for death losses). The price paid for the existing bull (set at $2,000) is considered the bench mark amount for calculating a breakeven price for the new bull. If the breakeven purchase price, calculated as the purchase price where the operation's profitability is the same for the new as the old bull (E), is less than what was paid for the existing bull then the new bull is less profitable than the existing bull and vice versa. Breakeven prices were calculated for each breed comparison by iteratively applying breed effects (A & B) at different purchase prices (D) until profitability per cow change (E) was zero between the old and new bull.

Results

Change in Profitability

Given the baseline farm operation outlined above, model results indicated that ten of the possible 17 different breeds increased farm profits when switching from an Angus bull with Commercial White cows (gray shaded column in Table 6). These ten breeds were Beefmaster, Gelbvieh, Hereford, Limousin, Red Angus, Salers, Santa Gertrudis, Short Horn, South Devon, and Tarentaise. These breeds were primarily more profitable because sale prices for a yellow hided calf were considerably greater than sale prices for a gray or white hided calf as would result with Angus bred Commercial White cows. A Tarentaise bull, that would sire yellow calves when bred to Commercial White cows, increased profitability by $18.76/cow or by 19 percent. The primary reason for this was due to the average increase in weaning weight and calf sale price with this cross resulting in over $486 more revenue from cattle. This bull selection also increased total cost by nearly $58 as sale barn expenses, feed costs, and veterinary costs all increased. The driver of profitability change in this scenario was thus on the revenue rather than the cost side.

For the other nine breeds, two were considered to have only minor impacts and seven led to decreased profitability. Of the seven breeds that were shown to make the operation less profitable a Brahman bull, on average, was shown to have the worst impact with a decrease of $87.42/cow or 89 percent decrease in returns. This was mainly a result of a substantial increase in calving difficulty (9.5%) and price discounts for the Brahman cross as the weaning weight moved to the next higher weight category and thereby lower prices. Similar switches to higher weight categories and attendant price discounts applied to Charolais and Simmental. Using the 2012 Across-Breed and Breed Average EPD information, Charolais, Simmental, and Tarentaise would sire calves with heavier birth and weaning weight than Angus bulls. Breeds shown to increase calving difficulty were Brahman, Charolais, and Shorthorn.

Change in GHG Emissions

The baseline farm had GHG emissions of 17.62 pounds of CO_2 equivalents per pound of beef sold. A negative number reported for the change in GHG emissions per live weight sold (F in Figure 1) shows a decrease in GHG emissions. Recall that changes in GHG emissions per live weight sold was a result of weaning weight changes, modified cow and calf losses as well as differential feeding needs. Breeds of bulls that are shown to decrease GHG emissions per live weight sold compared to the baseline with an existing Angus herd sire were Simmental and Tarentaise. These bull breeds decreased GHG emissions in the baseline scenario because calf weaning weight increased without an increase in calving difficulty. Compared to the Angus breed, Simmental bulls decreased GHG emissions the most with a change of -0.62 percent and Brahman bulls increased GHG emissions the most with a change of +8.40 percent. The Brahman bull increased GHG emissions due to the increased calving difficulty leading to more calf and cow losses thereby decreasing the number of animals and amount of beef sold. The decrease in beef sold had a greater impact than the weaning weight increase experienced with the Brahman bull.

Improvements in profitability did not go hand in hand with GHG emission mitigation. Of the ten breeds that improved profitability only one also lowered GHG emissions. Nonetheless, bull selection with the dual goal of increasing profitability and GHG mitigation converged on the same breed given the baseline genetics, price, and operating characteristics of the baseline farm. Also, profitability changes due to bull selection on average appeared to be greater in percentage terms than GHG emission changes. How sensitive the above findings are to changes in initial cow breed, price levels, and breed price factors is thus discussed next.

Sensitivity Analyses

Changes in GHG emissions for the six different commercial cow breeds shown in Table 6, using 2012 cattle prices and the associated breed price factors for the same amount of land, grazing strategy, and forage species show that the greatest level of overall farm profits was obtained with Commercial White cows and a Tarentaise bull ($117.25 per cow) followed closely by Commercial Black cows and a Tarentaise bull ($116.83) and Commercial Yellow cows with an Angus bull ($116.73). The smallest GHG emissions per cow were obtained with Commercial Spotted cows and Simmental bulls. The emissions reduction compared to the Angus bull baseline was never greater than one percent across the six cow breeds while, by comparison, emissions increases to the Angus bull baseline could be quite large (up to 10.87% when breeding Commercial Black cows to a Shorthorn bull). Further, Table 6 shows that out of the seventeen times that either farm profits increased or GHG emissions decreased compared to the Angus bull baseline, the two happened simultaneously only four times. Paying attention to both the profitability and GHG signal, pending many plausible different farm situations, it is thus stipulated that bull selection leads to relatively minor GHG emissions reductions but can have considerable net return implications (emissions reduction was less than 1% whereas profitability changed by as much as 19% on Commercial White cows). Further, as the cow breed changes, bull rankings across breeds change. Table 6 shows that by changing the cow breed, the most profitable new bull breed changes. On the basis of profitability, Angus was the top breed for Commercial Red and Commercial Yellow cows. On the other four cow breeds the Tarentaise bull outperformed the Angus bull. On the basis of GHG emission mitigation, Simmental was the top breed. For no cow breed did the highest profitability coincide with the lowest GHG emissions. Also, in all cases, profitability implications of changing bulls were larger in percentage terms than GHG emission changes.

Since breed, crossbreed, and hide color price ratios can change over time, bull selection on the basis of price premiums may change. Holding the baseline production practices constant while changing price levels and breed price factor choices, Figure 2 shows breed preferences that appear consistent over time. These trends show that both the greatest increase and decrease in profits across bull breeds were seen with 2012 cattle prices and 2010 breed price factors when compared to the other price level and breed price factor options. Many breeds had similar profit levels regardless of price level and breed price factors. Brahman bulls had the greatest variability in profit levels.

Breakeven Purchase Price

Using the baseline farm, 2012 cattle prices and 2010 breed price factors along with the Angus x Commercial White calves and a starting bull price of $2,000 per head, breakeven purchase prices for each breed were estimated (Figure 3) and follow the same pattern as Figure 2. Ten bull breeds had a breakeven purchase price greater than $2,000 with Tarentaise, Gelbvieh, and Limousin having a breakeven price greater than $3,000. Brangus, Braunvieh, Chiangus, Maine Anjou, and Simmental all had breakeven purchase prices below $2,000 but greater than $0. Brahman and Charolais bulls both had negative breakeven purchase prices. The breakeven purchase price for the Brahman bull was -$4,294; meaning that the operator would have to receive the bull for free and be paid $4,294 to receive the same level of profits as experienced with the Angus bull.

Discussion

The goal of this paper was to analyze profitability differences as a result of bull selection compared to a baseline of Angus sired calves from Commercial White cows using a recently released spreadsheet tool called FORCAP. Given the production conditions for the baseline farm as outlined above, the greatest increase in farm profits occurred when switching to a Tarentaise bull. The profitability increase was mainly a result of price premiums rather than changes in cost. The switch also resulted in a reduction in GHG emissions, but these reductions were not as large as the GHG reductions from switching to a Simmental bull. Modifying baseline genetics led to different bull genetics recommendations as changes in calving difficulty and anticipated price premiums played differential roles given different base cow breeds. Applying the same switch to a Tarentaise bull with a different base breed such as Commercial Red or Yellow cows was demonstrated to lead to negative profitability changes, for example. Further, profitability changes using different cattle price levels were relatively consistent over time at least for the baseline farm characteristics considered in this analysis.

Limitations of this analysis are that price premiums based on average price differentials by breed over the course of the entire year do not consider effects of sale month, sale location, or sale weight category. Further, different pasture management, calving season, cattle weight, and weaning age assumptions, or a different baseline cattle operation, may also lead to different results than reported within. Price changes due to shifts in 100 pound weight categories are large in this analysis as well. Future research may consider adjusting cattle prices by weight at a smaller increment than 100 pounds. Feedlot performance of calves as might be revealed in yearling weight EPD values is currently not considered and neither were marbling, ribeye area, and fat thickness. The cow-calf operator using FORCAP for bull selection thus may wish to consult several tools prior to making a breed choice. Nonetheless, FORCAP allows the producer to analyze economic and GHG emission tradeoffs with user-specified inputs.

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Figure 1. 'Genetics' spreadsheet tab (presented without bench mark comparison as would appear in FORCAP)

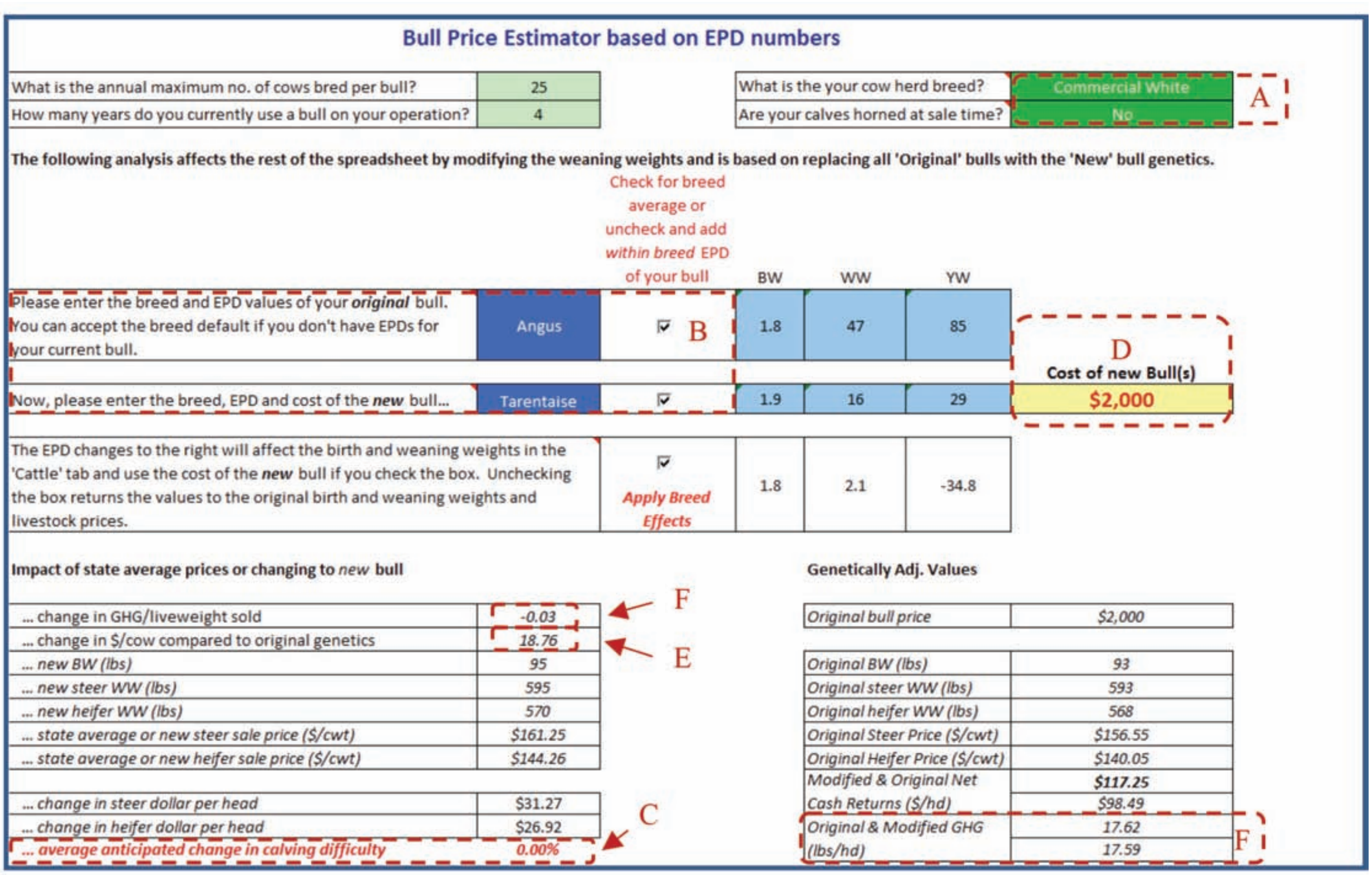

Figure 2. Profitability changes associated with bull selection using baseline farm characteristics with different price levels and associated breed price factors holding all other factors constant

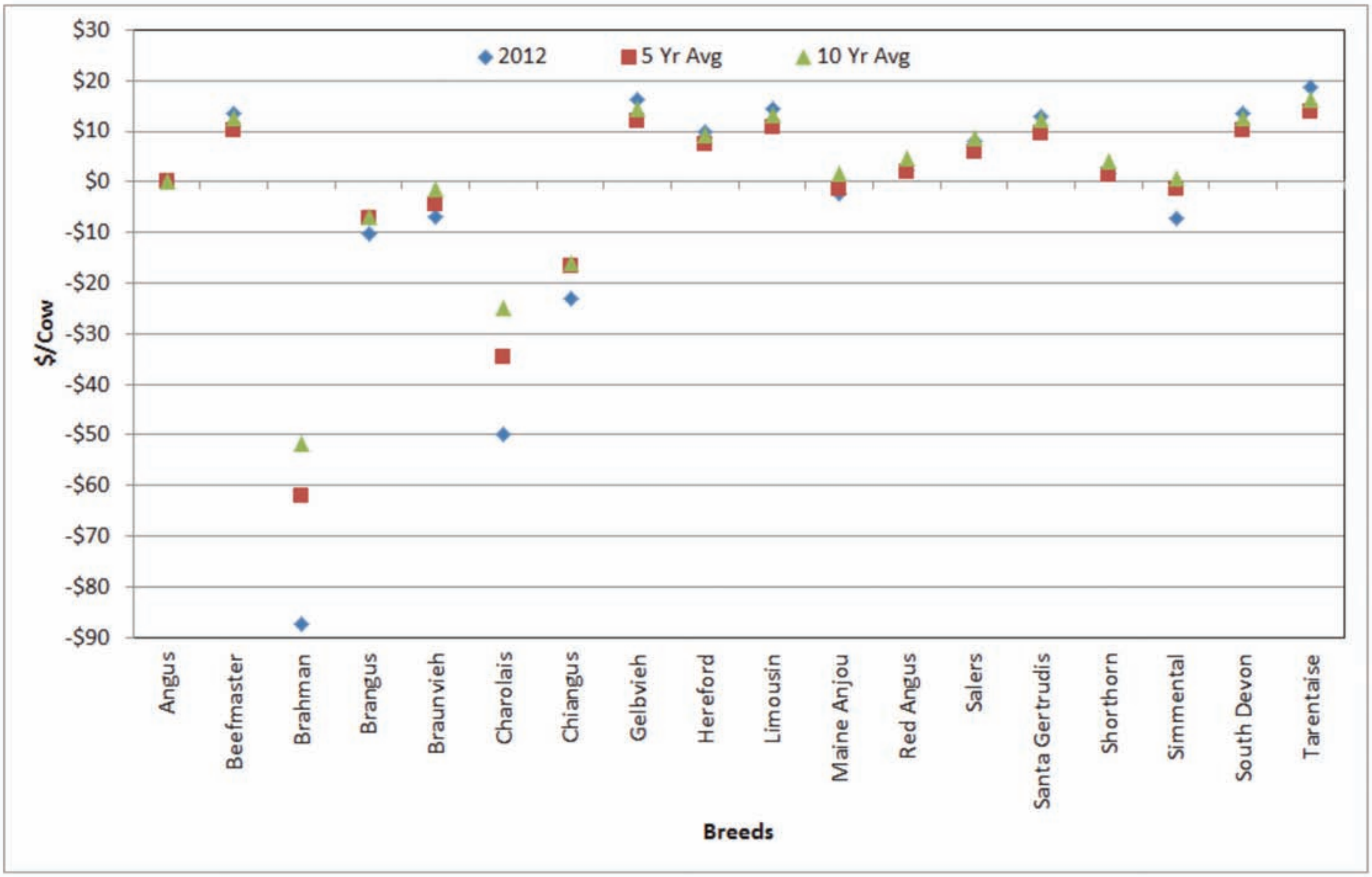

Figure 3. Breakeven purchase price for new bulls using 2012 price levels with 2010 breed price factors and $2,000 Angus bulls with Commercial White cows as the baseline cow herd in FORCAP

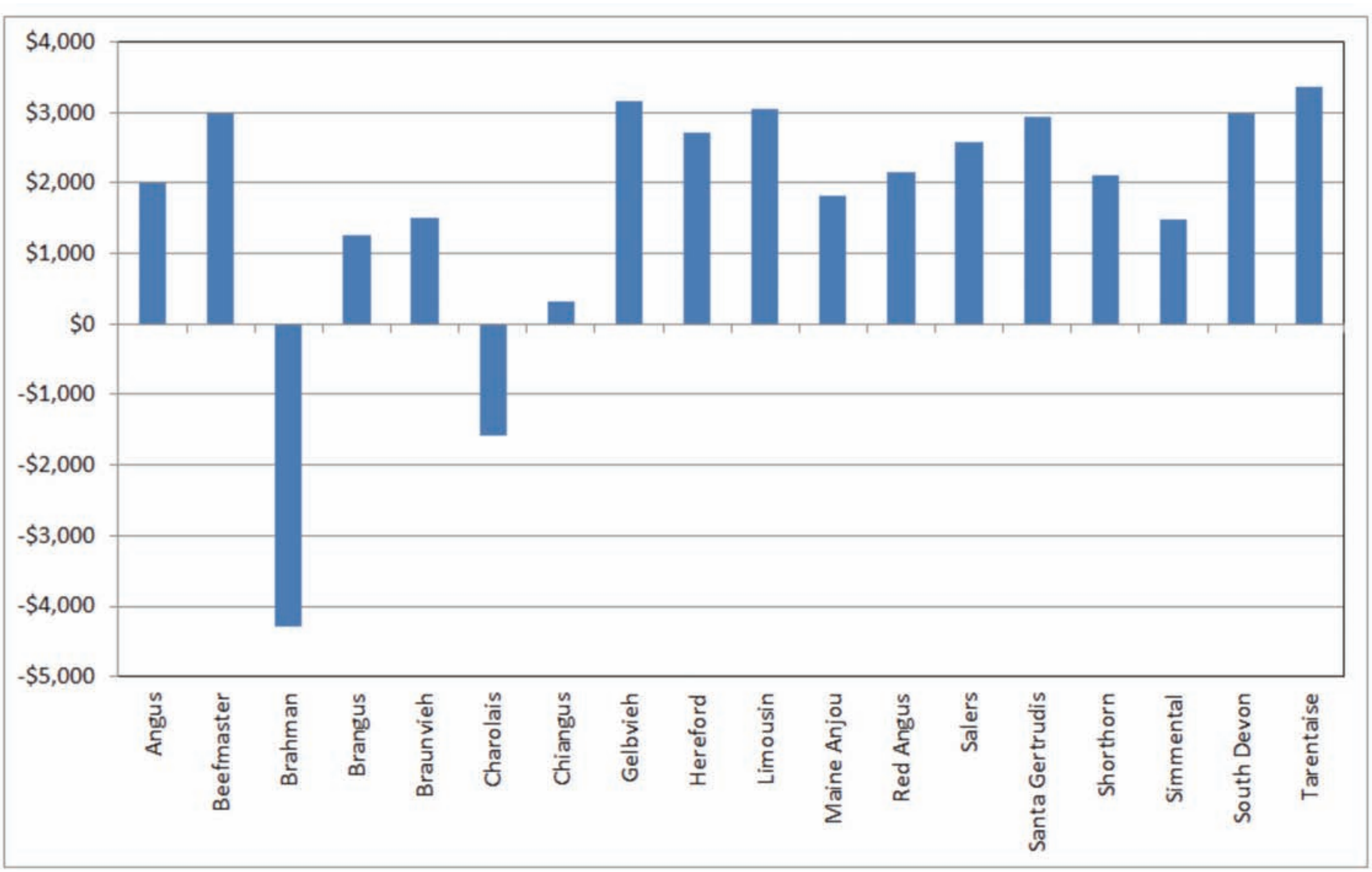

Table 1. U.S. Meat Animal Research Center (MARC) Across-breed and breed average EPDs for 2012

Breed	BW (lbs.)	WW (lbs.)	YW (lbs.)	MILK (lbs. of WW)	MARBLING (Marbling Score)	RIBEYE AREA (square inches)	FAT THICKNESS (inches)	BW (lbs.)	WW (lbs.)	YW (lbs.)
	Adjusted To Angus							*Breed Average*		
Angus	0.0	0.0	0.0	0.0	0.00	0.00	0.000	1.8	47	85
Beefmaster	6.7	35.3	32.5	7.8	--	--	--	0.3	8	13
Brahman	11.1	42.5	4.8	22.4	--	--	--	1.7	15	24
Brangus	3.7	13.0	13.5	6.8	--	--	--	0.7	23	42
Braunvieh	1.2	-19.2	-38.5	-0.4	-0.67	0.23	-0.095	2.8	41	64
Charolais	8.6	40.1	46.8	5.7	-0.46	0.92	-0.222	0.6	24	43
Chiangus	3.3	-14.9	-31.3	--	-0.42	0.40	-0.157	2	37	69
Gelbvieh	4.0	5.7	-13.5	13.6	--	--	--	1.2	40	75
Hereford	2.7	-2.8	-20.1	-16.7	-0.34	-0.11	-0.053	3.6	44	73
Limousin	3.8	-0.9	-34.7	-9.2	-0.70	1.07	--	1.5	45	83
Maine Anjou	4.1	-13.0	-34.5	-4.7	-0.79	0.88	-0.210	1.7	39	78
Red Angus	2.4	-0.6	-12.0	-3.1	0.03	-0.10	-0.034	-0.1	32	60
Salers	1.8	-3.1	-14.3	2.4	-0.11	0.75	-0.210	1.8	41	79
Santa Gertrudis	7.4	37.7	33.9	--	-0.67	-0.19	-0.115	0.6	5	7
Shorthorn	6.0	15.7	39.4	17.9	-0.14	0.17	-0.148	2.4	15	24
Simmental	5.2	24.9	22.4	19.8	-0.55	0.92	-0.215	0.7	31	56
South Devon	4.2	3.2	-6.3	-2.3	0.05	0.15	-0.111	2.6	40	76
Tarentaise	1.7	33.1	21.2	23.4	--	--	--	1.9	16	29

Sources: Kuehn and Thallman 2012a and c.

Table 2. Breed price adjustment factors for breed, hide color, and polled status relative to Arkansas state average prices for feeder cattle in 2000, 2005, and 2010

	Breed to State Average Price Ratio			Breeds & Cross Breeds Price Ratio was Applied to
Breed by Year	**2010**	**2005**	**2000**	
Angus	1.026	1.028	0.996	A[b]
Brahman	0.869	0.917	0.864	B
Charolais	1.001	1.000	1.022	C
Hereford	1.011	0.908	0.890	H
Limousin	0.995	0.990	1.016	L
Simmental	0.920	0.948	0.957	S
1/2 Brahman Cross	0.970	0.987	0.986	B x AO, Br x Br
1/4 Brahman Cross	0.969	0.950	0.979	Br x AO
Angus x 1/4 Brahman	0.987	0.983	0.993	A x Br
Angus x Brahman	1.030	0.983	1.021	A x B
Angus x Charolais	1.006	1.021	0.991	A x C
Angus x Hereford	1.029	1.031	1.013	A x H
Angus x Hereford x 1/4 B	1.015	0.973	1.024[a]	A x Be
Angus x Hereford x B	1.003	1.016	1.024	B x Be
Charolais x Limousin	0.999	1.027	1.046	C x L
Hereford x 1/4 Brahman	0.959	0.973	1.112	H x Be
Hereford x Charolais	1.017	1.039	1.029	H x C
Hereford x Limousin	0.992	0.998	1.020	H x L
Black	1.015	1.010	1.006	A x AO, Br x AO, Ch x AO
Black White Faced	1.029	1.016	1.016	A x H or S, Br x H or S, Ch x H or S
Gray	0.984	0.996	0.980	A x CW, Br x C or CW, Ch x C or CW
Red	0.956	0.965	0.990	Be, Bv, G, L, M, R, Sa, Sg, Sh, Sd, T, CR
Red White Faced	0.962	0.970	0.980	H x AR, S x AR
Spotted/Striped	0.757	0.909	0.895	Sp x AO
White	0.963	0.982	1.013	C x CY or CW
Yellow	1.014	1.019	1.030	C x AR
Yellow White Faced	1.011	1.020	1.021	C x H or S
Horned Cattle	0.927	0.969	0.984	

[a] The exact price was not reported for the given year so the closest substitute of Angus x Herford x Brahman was used.

[b] A = Angus, B = Brahman, C = Charolais, H = Hereford, L = Limousin, S = Simmental, Br = Brangus, Be = Beefmaster, Ch = Chiangus, CW = Commercial White, Bv = Braunvieh, G = Gelbvieh, M = Maine Anjou, R = Red Angus, Sa = Salers, Sg = Santa Gertrudis, Sh = Shorthorn, Sd = South Devon, T = Tarentaise, CR = Commercial Red, AR = All in red hide group, Sp = Spotted/Striped, Commercial Yellow, AO = All Other

Sources: Troxel and Barham 2012, Barham and Troxel 2007, Troxel et al. 2002.

Table 3. Operating input prices used by FORCAP

Item and Description	Unit	2012	5-yr Avg.	10-yr Avg.	Item and Description	Unit	2012
LIVESTOCK					**FEED**		
3 - 400 lb. Steers[a]	$/cwt	193.99	144.47	139.49	Hay delivered -- 4' x 5' (800 lbs)	$/bale	45
4 - 500 lb. Steers[a]	$/cwt	174.96	133.47	127.31	Corn	$/lb	0.15
5 - 600 lb. Steers[a]	$/cwt	159.04	123.58	117.24	Salt & Minerals (50 lb bag)	$/bag	20
6 - 700 lb. Steers[a]	$/cwt	146.60	115.71	109.83	**FERTILIZER**		
3 - 400 lb. Heifers[a]	$/cwt	165.28	123.16	120.66	Lime	$/ton	30
4 - 500 lb. Heifers[a]	$/cwt	152.85	116.34	112.69	Ammonium Nitrate (34-0-0)	$/ton	506
5 - 600 lb. Heifers[a]	$/cwt	142.28	110.21	106.12	Poultry Litter (3-2-3)	$/ton	36
6 - 700 lb. Heifers[a]	$/cwt	133.87	105.41	101.02	Application cost per acre	$/acre	6
Cull Cow[b]	$/cwt	76.35	57.73	52.36	**FUEL USE & OTHER MISCELLANEOUS**		
Purchase Price of Breeding Bull	$/hd	2,000	2,000	2,000	Fuel use per acre for mowing, raking and staging	gal	4.5
Cull Bull[c]	$/cwt	92.28	70.66	64.71	Amortized Pasture/hay maintenance & establishment[d]	$/acre	14
Beef Check Off, Ins. & Yardage	$/hd	2.75			Fuel use per day for feeding	gal	0.64
Sales Commission	% of sales	3.50			Fuel use per day for checking cattle	gal	1
VETERINARY SERVICE CHARGES					Twine	$/bale	1
Prolapse	($/hd)	75			Cost for Farm Vehicle	$/month	45
Caesarian section	($/hd)	225			Fuel cost	$/gal	3.50
Sick treatment (avg. drug charge)	($/hd)	15			Operating interest[e]	%	6
Bull Soundness	($/hd)	30					

[a] State average, medium and large frame No. 1 prices as reported by the United States Department of Agriculture, Agricultural Market Service by Steve Cheney, Little Rock, AR. The average of all monthly prices is used for sale months that are split across several marketing months with a year round calving distribution.
[b] 75-80% Lean Breaking Utility
[c] Yield Grade 1-2, 1,000 to 2,100 lbs
[d] Based on 10 year life of stand and standard seedbed preparation and weed control expenses
[e] Charged on half the cash operating expenses incurred per year to reflect.

Table 4. Bull breed means for 2010-born animals under U.S. Meat Animal Research Center conditions

Breed	Birth Weight (lbs.)	Weaning Weight (lbs.)[a]	Breed	Birth Weight (lbs.)	Weaning Weight (lbs.)[a]
Angus	89.8	582.0	Gelbvieh	93.3	580.8
Hereford	94.3	576.2	Limousin	93.3	579.5
Red Angus	90.3	566.3	Maine-Anjou	93.8	561.4
Shorthorn	96.3	565.7	Salers	91.6	573.2
South Devon	94.8	578.7	Simmental	93.9	590.7
Beefmaster	95.0	578.3	Tarentaise	91.6	584.1
Brahman	100.8	592.2	Commercial[b]	93.9	576.2
Brangus	92.4	571.0	Commercial Black[b]	92.6	573.0
Santa Gertrudis	96.0	577.7	Commercial Red[b]	93.7	576.1
Braunvieh	92.1	556.7	Commercial White[b]	96.1	578.0
Charolais	97.2	599.3	Commercial Yellow[b]	94.3	577.3
Chiangus	93.2	556.9	Commercial Spotted[b]	94.8	581.5

[a] A 25 lb. spread was applied to the steer and heifer weights (12.5 lbs. above and below the average respectively).

[b] Weights were not reported in original document and are an average of all breeds that fit into the specific group.

Source: Kuehn and Thallman 2012b.

Table 5. Summary of cattle management practices using Commercial White cows and Angus bulls

Description		Herd Size and Description	
Days on Hay & Supplements	153	Cows (avg. age 65 months)	38
Days on Pasture	212	Young Cows (avg. age 30 months)	7
Breeding failures	14%	Cow herd size	45
Cow death losses	1%	Replacement heifers	7
Calf death losses	3%	Bulls	2
Avg. culling age of cows	7.83	Male calves sold	19
Avg. number of calves over life of cow	6	Female calves sold	12
Weight of mature cow in lbs	1,250	Cull cows	7
Weight of young cow (at first calf) in lbs	1,000	No. of years between bull purchases	2
Weaning age in months	7	Cow death losses	0
Avg. age of replacements at first breeding	15	Calf death losses	2
Avg. birth weight in lbs	93	Hay Waste with feeding & storage	20%
Avg. steer weaning weight in lbs	593	**Hay sold**	
Avg. heifer weaning weight in lbs	568	hay produced minus hay needed (lbs)	7,872
Avg. bull weight in lbs	2,000	Number of 800 lb. round bales (incl. harvest from pasture)	11
Calving Season	Year-round	Pasture acres per cow	4

Table 6. Profitability and GHG emission change as base cow breed changes using 2012 cattle prices, adjusted birth and weaning weights and associated breed price factors holding all other cattle and pasture management strategies constant

Cow Breed / **Bull Breed**	Commercial		Commercial Black		Commercial Red	
	NR[a] ($/hd)	**GHG**[b] (% Change)	**NR** ($/hd)	**GHG** (% Change)	**NR** ($/hd)	**GHG** (% Change)
Angus	$86.96	17.62	$114.66	17.66	$115.69	17.65
Beefmaster	-$26.35	5.62%	-$60.98	9.68%	-$60.60	5.61%
Brahman	-$73.55	5.45%	-$76.48	5.32%	-$107.89	5.38%
Brangus	-$9.94	1.02%	-$10.48	0.91%	-$10.49	0.96%
Braunvieh	-$22.99	2.10%	-$24.27	2.10%	-$57.94	2.10%
Charolais	-$70.42	7.83%	-$87.97	7.70%	-$73.06	7.82%
Chiangus	-$22.70	2.04%	-$45.72	7.47%	-$23.97	2.04%
Gelbvieh	-$1.30	0.17%	-$24.04	5.38%	-$36.47	0.11%
Hereford	-$5.72	0.57%	-$19.67	5.72%	-$37.13	0.51%
Limousin	-$2.87	0.34%	-$24.80	5.49%	-$38.02	0.28%
Maine Anjou	-$18.87	1.87%	-$41.69	7.08%	-$53.85	1.64%
Red Angus	-$14.45	1.36%	-$15.23	1.19%	-$49.48	1.19%
Salers	-$8.95	0.85%	-$8.52	0.79%	-$44.05	0.79%
Santa Gertrudis	-$26.04	5.68%	-$61.56	9.74%	-$61.18	5.61%
Shorthorn	-$36.91	6.75%	-$71.37	10.87%	-$104.38	10.93%
Simmental	-$22.02	***-0.62%***	-$5.18	4.47%	-$53.32	***-0.68%***[c]
South Devon	-$3.75	0.40%	-$61.08	9.74%	-$38.89	0.34%
Tarentaise	***$1.16***	***-0.17%***	***$2.17***	***-0.23%***	-$33.15	***-0.23%***

[a] Net Cash Return (NR) is measured in $/cow and includes revenue less all operating costs of hay, fertilizer, fuel, supplemental feed, veterinary and medicine charges, sales commission, check off, yardage and insurance and operating interest. The Angus Bull breed shows the baseline performance and numbers below reflect change from the baseline.

[b] GHG is measured in lbs of CO_2 per pound of liveweight sold and numbers below reflect change from the baseline in %.

[c] Italics denote when either NR increase or GHG emissions decrease. Both conditions apply in yellow shaded cells.

Table 6. Profitability and GHG change as base cow breed changes … (cont'd.)

Cow Breed / Bull Breed	Commercial Yellow		Commercial Spotted		Commercial White	
	NR[a] ($/hd)	**GHG**[b] (% Change)	**NR** ($/hd)	**GHG** (% Change)	**NR** ($/hd)	**GHG** (% Change)
Angus	$116.73	17.62	-$35.54	17.59	$98.49	17.62
Beefmaster	-$38.87	0.40%	-$1.98	0.40%	***$13.64***	0.40%
Brahman	-$77.93	5.45%	-$58.33	5.51%	-$87.42	8.40%
Brangus	-$10.49	1.02%	-$7.61	1.02%	-$10.15	1.02%
Braunvieh	-$58.00	2.10%	-$16.78	2.05%	-$6.75	2.10%
Charolais	-$101.25	7.89%	-$33.44	3.75%	-$49.78	3.80%
Chiangus	-$23.97	2.04%	-$16.56	2.05%	-$23.19	2.04%
Gelbvieh	-$2.12	0.17%	-$0.12	0.11%	***$16.13***	0.17%
Hereford	-$8.28	0.57%	-$3.61	0.57%	***$9.97***	0.57%
Limousin	-$38.09	0.34%	-$1.36	0.28%	***$14.48***	0.34%
Maine Anjou	-$53.92	1.87%	-$13.55	1.88%	-$2.42	1.87%
Red Angus	-$49.55	1.36%	-$10.26	1.36%	***$2.27***	1.36%
Salers	-$44.12	0.85%	-$6.14	0.85%	***$8.08***	0.85%
Santa Gertrudis	-$61.25	5.68%	-$25.14	5.69%	***$13.02***	0.45%
Shorthorn	-$72.01	6.81%	-$32.60	6.82%	***$1.53***	1.48%
Simmental	-$25.28	***-0.62%***	-$16.73	***-0.63%***	-$7.07	***-0.62%***
South Devon	-$38.97	0.40%	-$2.06	0.40%	***$13.54***	0.40%
Tarentaise	-$34.10	***-0.17%***	***$1.61***	***-0.17%***	***$18.76***	***-0.17%***

[a] Net Cash Return (NR) is measured in $/cow and includes revenue less all operating costs of hay, fertilizer, fuel, supplemental feed, veterinary and medicine charges, sales commission, check off, yardage and insurance and operating interest. The Angus Bull breed shows the baseline performance and numbers below reflect change from the baseline.

[b] GHG is measured in lbs of CO_2 per pound of liveweight sold and numbers below reflect change from the baseline in %.

[c] Italics denote when either NR increase or GHG emissions decrease. Both conditions apply in yellow shaded cells.